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CAR BUILDER AND RAILROAD JOURNAL.

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THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

IV.

(Continued from page 206.)

A systematic description of the shops at Altoona, and of what they contain, would not be easy to write. In fact it would be difficult to devise a comprehensive system, or skeleton, for a complete description. As no attempt at completeness is aimed at in these articles, it will not be necessary to follow any particular method in writing or arranging them—all that will be attempted will be to note and describe the various interesting features which the writer had the opportunity of observing, aiming only to make the descriptions easily comprehensible by the reader.

CHILLED CAST-IRON TOOLS.

The use of chilled cast-iron tools in these shops for lathes, planers and boring machines will probably be a novelty to many of our readers, as it was to the writer. These are used for turning, boring and planing both wrought and cast iron and brass. It is found that they will not stand the service of cutting steel, as the cast iron has not sufficient strength to resist the strain, and the cutting edges of the tools crumble in doing that kind of work.

These tools are cast from the ordinary iron used for making chilled wheels, the point or cutting end being chilled, and then

ground in the usual way. It is said that they stand equally as well or better than steel tools do, and are very much cheaper, and are cast in exactly the right form required, and being made from a pattern, are uniform in shape and size.

The various kinds which are made and used are shown in the engraving herewith, Fig. 1, which was reproduced from a photograph, and the list of sizes will indicate the uses in which they are employed.

PNEUMATIC ASH-HOIST.

The economical handling of ashes from locomotives is a problem on which a great deal of thought and ingenuity has been exercised. At Altoona several pneumatic ash-hoists have been designed and erected, and are now working very satisfactorily. The latest of these is illustrated in Fig. 2 and, as will be seen, consists of an iron frame resembling a gallows, with capacity for hanging half-a-dozen culprits at once. The frame extends across three tracks. The view shown in Fig. 2 was taken from a point near the westerly door of round-house No. 3, the latter being behind the observer.* A part of the sand-house, which is indicated in the plan, is shown on the right side of the engraving. The track on which the engine is standing leads directly into the round-house. It will be seen that this track has a pit underneath and in front of the engine. The bottom of this pit has a narrow-gage track on which small trucks run and carry what may be called bifurcated buckets to receive the ashes as it is removed from the ash-pans of the engines.

The tops of two of these buckets are shown in the pit, and one is suspended over the car, alongside of the engine, with its two halves opened, to deliver its contents into the car below. When an engine is to be de-ashed—to coin a word—one of the trucks with a bucket on it is run under the engine, and the ashes are raked out of the ash-pan into the bucket. After it is filled either the engine can be run forward or back, so that the bucket can be reached by the hoist, or if the engine is not below the hoist when

* The round-house is shown in the plan published last month, page 204.



Fig. 2.—Pneumatic Ash Hoists in the Altoona Yard of the Pennsylvania Railroad.

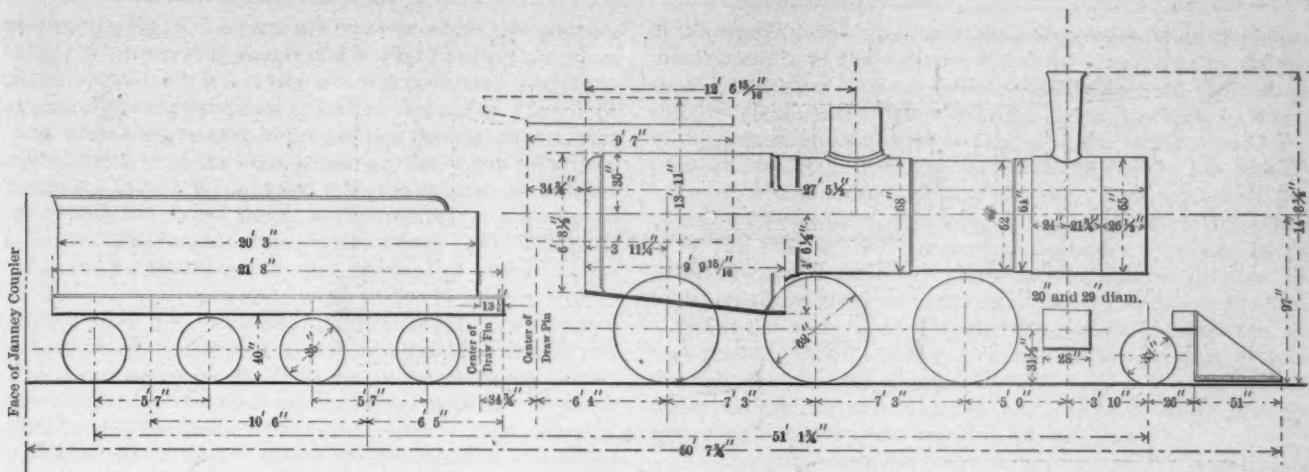


Fig. 3.—Outline of Compound Mogul Locomotives—Pennsylvania Railroad.

take to read this description of it, and saves much work of a very disagreeable kind.

PNEUMATIC SANDING APPARATUS.

The 7-shaped pipe or stand, with a ladder leaning against it, shown on the left side of the engraving, is one of the pneumatic sanding appliances which are used to fill the sand-boxes of locomotives. The sand-house on the right has a sand-dryer of a usual kind. A cylindrical reservoir or tank, $3\frac{1}{2}$ feet in diameter and $5\frac{1}{2}$ feet deep, is placed below the dryer, usually under the floor. This receptacle has a valve on top, through which the sand is fed into the tank. From the bottom of it a pipe communicates with the vertical 7 pipe shown in the engraving. The valve on top of the sand reservoir opens inward, so that when compressed air is admitted the valve is closed, but it passes through the sand and into the pipe at the bottom and thence to the 7 pipe, and in doing so carries the sand with it. The end of the pipe has a valve and hose which are shown, the hose being intended to conduct the sand to the sand-boxes. A few minutes is all the time required to fill a sand-box, which is done by simply turning on the compressed air when the reservoir contains a sufficient quantity of sand.

COMPOUND LOCOMOTIVES.

A very interesting series of experiments has been in progress on the Pennsylvania Railroad for some time past. It was determined by the managers of the company a year or more ago to make a thorough test of the compound system for locomotives, and to do this four mogul freight engines were built all alike, excepting that a different system of compounding was adopted in each en-

gine. The diagrammatic engraving, Fig. 3, herewith, gives the proportions and principle dimensions of these engines. The systems of compounding which were adopted were the Gölsdorf, Van Borries, Pittsburgh and Richmond.

These engines were all completed some months ago, and have since been undergoing a most thorough series of tests in actual service, the results of which cannot help being very interesting to railroad men generally. At the time of our visit to Altoona the tests were not completed, so that no results can at present be given. All that can be said is that a very decided economy in coal consumption by the compound over the simple engines was indicated by the tests so far as they have been made.

We are indebted to Mr. Vogt and Mr. Casanave for a series of diagrams showing the principal features of the various compound systems as they have been applied to the engines referred to.

THE GÖLSDORF SYSTEM.

Fig. 4 represents a transverse section through the cylinders of the engine to which this system of compounding was applied. It will not be necessary to explain to many of our readers that in compound locomotives some special provision must be made to admit steam to the low-pressure cylinder in starting; but in order that those who are not familiar with the compound principle may read this understandingly it may be said that in such engines steam is admitted first to the high-pressure cylinder, and after acting on the piston, it is allowed to escape to a larger or low-pressure cylinder, where it again acts on another piston, and then escapes up the chimney. As the steam is admitted first to the high-pressure cylinder, unless some special provision is made therefor,

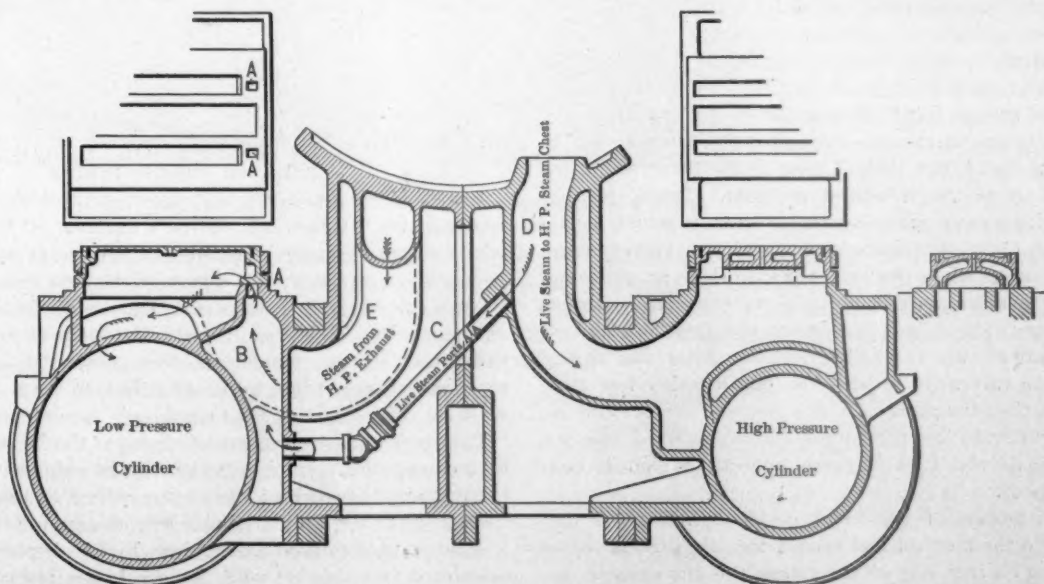


Fig. 4.—Gölsdorf System of Compounding as applied to a Mogul Locomotive by the Pennsylvania Railroad.

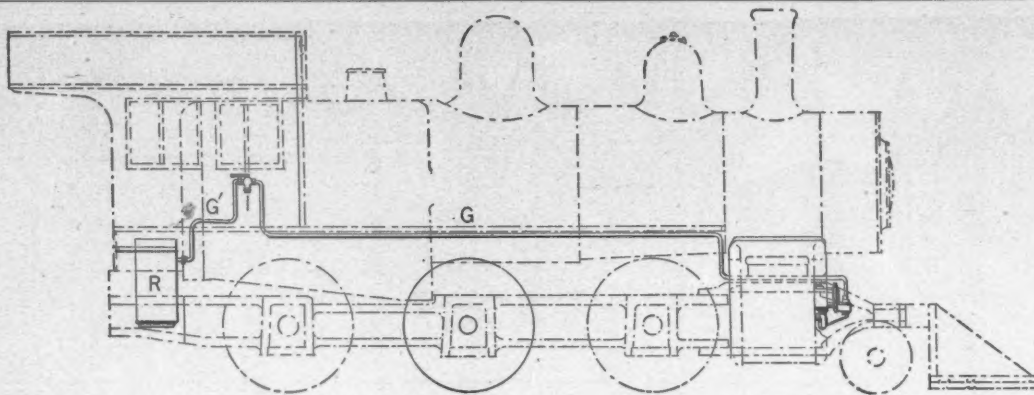
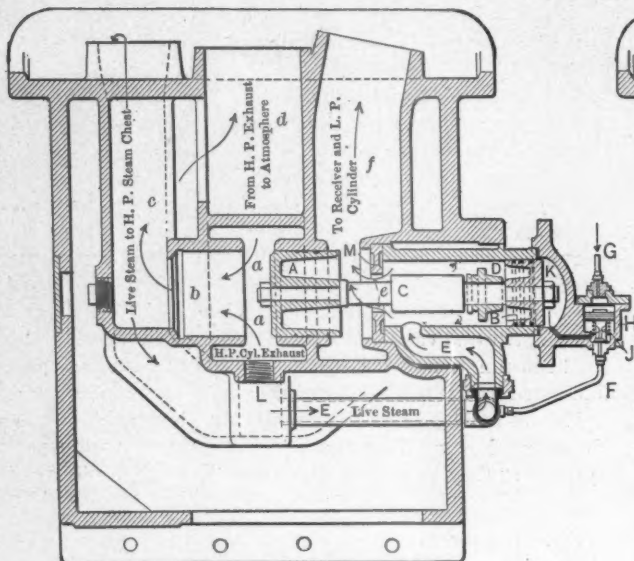
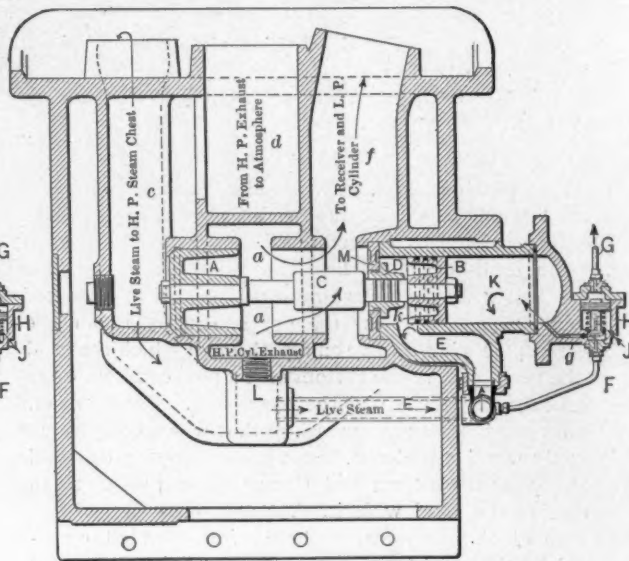


Fig. 5.



POSITION OF VALVE WHEN ENGINE IS WORKING SIMPLE.



POSITION OF VALVE WHEN ENGINE IS WORKING COMPOUND.

Fig. 6.

Fig. 7.

The Von Borries System as Applied to a Compound Morsul Locomotive by the Pennsylvania Railroad.

no steam would enter the low-pressure cylinder during the first revolution of the wheels, and, as a matter of fact, owing to the cylinders often being cold in starting much of the steam which is then admitted to them is condensed and for a number of revolutions little would flow into the second cylinder. Furthermore, the engine might be standing in such a position that the low pressure piston was at or near the end of its stroke and unable to exert much tractive effort. It is therefore essential in compound locomotives to provide means for admitting steam direct from the boiler to the low-pressure cylinder in starting.

In the Golsdorf system this is accomplished by openings *AA*, which are made in the valve-seat. One of these is shown in the sectional view in Fig. 4, and both of them in the plan view of the valve-seat just above the left-hand cylinder. These openings communicate with a cavity in the cylinder casting, which is connected by a pipe *C* to the steam-pipe *D* of the high-pressure cylinder. In starting when the valves are worked at their full stroke or nearly so their steam edges will uncover the openings *AA*, and by means of the pipe *C* live steam will thus be admitted to the low-pressure steam-chest and cylinder. After the engine is started, and the valves are worked at considerably less than their full stroke, then the parts *AA* are not uncovered and no live steam can enter the low-pressure cylinder, but it is supplied from the exhaust of the high-pressure cylinder which is connected to the pipe *E*.

From the steam-chest of the low-pressure cylinder the live steam passes into the receiver and thence into the high-pressure cylinder, entering on that side of the piston therein which is opposite to that in which the movement of the piston ought to take place.

Thus the steam entering the high-pressure cylinder will exercise a certain counter pressure which, however, will be overcome by live steam from the boiler as soon as the position of the crank undergoes the slightest alteration, such live steam from the boiler entering directly into the high-pressure cylinder.

When the low-pressure slide-valve assumes such a position that the port which until then has been open is closed, the direct admission of steam into the low-pressure cylinder will be discontinued, and, therefore, any injurious counter-pressure that might otherwise result therefrom, is completely obviated, so that the locomotive can then be started by the steam pressure exerted upon the high-pressure piston alone.

THE VON BORRIES SYSTEM.

Professor Woods, in the last edition of his book on "Compound Locomotives," says that "after a number of years' experience with automatic starting gears, that give increased power to compound locomotives, during a part of the first revolution, Mr. von Borries has reached the important conclusion that an independent exhaust with a high-pressure cylinder, such as used by Mallet, is necessary for two-cylinder receiver compounds, with cranks at right angles, when the locomotive has to start heavy trains or work on comparatively heavy grades."

This device has been adopted in one of the Pennsylvania Railroad compounds. In order to enable the engineer to control the exhaust and the working of the two cylinders, that is, to change them so as to work either simple or compound, a three-way cock *I*—shown in the diagrammatic view, Fig. 5—is provided, which is connected by a pipe *G*¹ with the air brake reservoir *R* and by another pipe *G*, with an apparatus on the front end of the cylinder castings shown in Figs. 6 and 7 in sectional views and on a

larger scale. In Fig. 6, the parts are represented in the position they occupy when working simple and in Fig. 7 as they are when working compound; *a* is a cavity which is connected directly to the exhaust of the high-pressure cylinder. From Fig. 7 it will be seen that when the parts are in the position therein shown that the exhaust steam from the high-pressure cylinder will pass from the passage *a*, which is connected with the exhaust of the high-pressure cylinder to *f*, and thence to the receiver and low pressure cylinder. The engine then works compound. The parts are held in the position shown by the pressure of steam in the cylinder *K*.

To change the engine to simple working in starting, compressed air is admitted by the three-way cock *I* and pipe *G*, Figs. 5 and 6, to the operating valve *H*. This has a small piston inside, which is connected to a double-seated valve below it. When air is admitted above the piston it is forced down, which closes the opening below the valve and shuts off communication with the pipe *F*. At the same time the valve leaves its top seat, which opens communication through the passage *g*, between the cylinder *K* and the outlet *J*, which is open to the atmosphere. The steam in *K* can thus escape. The opposite end *k* of the cylinder is connected by pipes *EE* with the live-steam pipe. Consequently that end of the cylinder is filled with steam which acts in the piston *B*, which moves it and the parts with which it is connected toward the right or into the position shown in Fig. 7. From this it will be seen that by this movement the piston *A* has been unseated and that communication has been opened from

in the pipe *F*, below the valve, will then raise it and close communication from the cylinder *K* and the atmosphere by the passage *J*, and open a passage from *F* through *g* to *K*, thus admitting live steam to the right side of the piston *B*, which, by reason of the greater effective area on that side, due to the reduction of pressure resulting from the steam flowing to the low-pressure cylinder, will be moved towards the left. This movement first shuts off live steam communication at *e*, Fig. 6, from the pipe *E* to the receiver, and low-pressure cylinder, by means of the reducing plug *C* and then closes communication between the high-pressure exhaust and atmosphere by the seating of the valve *A* and at the same time opening communication between the high-pressure exhaust passage *a* and the low-pressure cylinder through the receiver passage *f*. The engine is thus entirely under the control of the runner and can be instantly changed from simple to compound working or *vice versa*.

The engravings and explanation have occupied so much space that the description and illustrations of the other two compounds must be reserved for the next article.

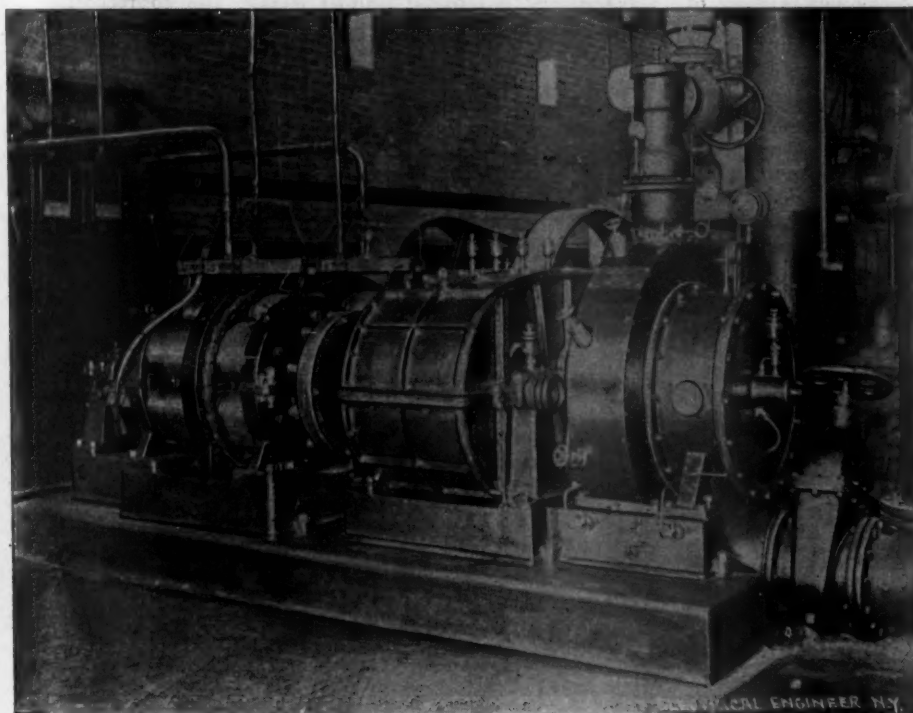
Performance of a 300-Horse Power De Laval Steam Turbine in an Electric Lighting Station.

Some time ago the Edison Electric Illuminating Company, of New York, contracted with the Société de Laval, of Paris, for two 300 horse-power De Laval steam turbines. One of these now installed in the Twelfth street station in New York has recently

been tested by Messrs. Breguet and Van Vleck, the former representing the builders and the latter the purchasers.

The turbine disc has a diameter of 29½ inches and a thickness through the blades of about ¼ inch, and it runs at 9,000 revolutions per minute. The motion is transmitted by gearing to two Desroziere dynamos running at 750 revolutions. The entire equipment of one turbine, its gearing and two dynamos occupy a floor space of 13 feet 3 inches by 6 feet 5½ inches, and a height of only 4 feet 3 inches. When operating condensing with a steam pressure of 145 pounds above the atmosphere and a vacuum of 26 inches, the steam consumption was guaranteed to be not more than 18.7 pounds per brake horsepower under full load.

In the accompanying illustration is shown the apparatus tested. The steam is supplied to the turbine through the large valve on top of it and the jets are turned on and off by the small valves around the periphery of the casing, three of them being in sight in the photograph. The exhaust passes out through the large valve below and to the right of the turbine. The gears are



300-Horse Power De Laval Turbine at Twelfth Street Edison Station, New York.

the cavity *a*, which communicates with the exhaust of the high-pressure cylinder to *d*, which latter leads to the atmosphere.

When the parts are in the position shown the exhaust steam from the high-pressure cylinder can therefore escape directly through the passage *b* to *d*, as indicated by the arrows, and thence to the open air. This cylinder is then working simple. At the same time live steam can flow through the pipes *E*, *E*, passage *e*, into *f*, which is connected with the reservoir and low-pressure cylinder. Under these conditions both cylinders will work simple. It should be explained that the parts shown in the engraving, that is the pistons *A* and *B*, and plug *C*, are kept in the position in which they are represented by the pressure of the live steam on the left side of the piston *B*.

To work the engine compound the air pressure in the operating valve *H* is released by the three-way cock. The steam pressure

in the casing to the left of the turbine and there is a second dynamo directly back of the one in the foreground.

The tests were each of six hours' duration and all readings were taken by two observers. The result of the full load test is as follows:

Average of readings:

127.25 volts.	692.48 amps.	128.26 volts.	709.18 amps.
127.25 × 692.48 = 88,118.080 watts + side			
128.26 × 709.18 = 90,959.427 " - side			
Avg. watts.... 179,077.507 " both sides			
179,077.507 is 90 per cent. of 198,975.01 watts = 266.72 h. p. × 6 = 1,600.32 h. p. hours.			
Weight of water discharged from air pump, 6 hrs. = 27.763 lbs.			
H. P. hours developed..... 6 hrs. = 1,600.32			
Lbs. of water per B. H. P. hour..... 17.348 lbs.			
Lbs. of water per E. H. P. hour..... 19.275 lbs.			

The result of tests with varying loads is given below, the num-

ber of jets in use varying from two to seven in the different tests:

No. of jets used.	Average load		Average watts		Per cent. of full load.	Vacuum.	Pounds of steam per E. H. P.
	+ Amps.	- Amps.	+ Amps.	- Amps.			
2	153.78	147.15	18,707	18,283	18.50	27.	27.35
4	453.60	455.80	54,156	57,886	56.02	26.43	20.22
6	700.85	718.65	87,746	91,268	89.51	26.07	19.75
7	771.94	787.83	97,418	100,856	99.14	25.79	19.95

In making these tests the power readings were obtained from the delivery of the dynamos, and the electrical horse-powers given above and the steam consumptions per electric horse-power are therefore the result of direct observation. The brake horse-power is calculated by assuming that the dynamos have an efficiency of 90 per cent.

We understand that these are the first Laval steam turbines of such large power to be put into commercial use in this country.

Communications.

A Novel Method of Obtaining Dynamometer Cards.

PHILADELPHIA, Aug. 25, 1896.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

At a recent engine test near Stroudsburg, Pa., conducted by Edwin E. Boyer, M. E., of Philadelphia, a novel instrument to obtain a card from the dynamometer was presented, and caused some little comment.

The dynamometer was the ordinary prony brake, but in place of the customary platform scales, at the end of the arm was placed a spring made from $\frac{1}{2}$ -inch steel, wound on a 2-inch core, and designed from Begtrup's formula, to be of such a length as to give a deflection of 3 inches under its maximum load of 2,500 pounds.

This spring was placed in a hollow cylinder which carried a scale graduated for every hundred pounds. On the index of the spring was fastened a pencil which pressed against the card carried by an aluminum cylinder about 3.8 inches in diameter and $3\frac{1}{4}$ inches high.

This cylinder was operated by clockwork to revolve once an hour, and was so adjusted that the maximum movement of the index (3 inches) was produced on the card.

The ordinate on the card was divided in 25 spaces, each space therefore representing 100 pounds pull, and the abscissa was divided into 120 spaces, each space representing an interval of 30 seconds.

The duration of the test was 8 hours, and indicator cards were taken from each end of the cylinder every 10 minutes.

The necessity of a dynamometer card was caused by the great vibration of the arm of the brake, these vibrations being too great to obtain accurate results with platform scales.

The test was in every respect a success, and reflects much credit on the young engineer in charge.

R. M. WILSON.

Tests of Car Wheels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

We have noted with interest the correspondence in your September issue concerning the special tests made on cast-iron wheels by casting a ring of molten iron around the rim of the wheels.

The company with which the writer is connected has made a great many experiments in this direction which are interesting in a sense, but they are entirely useless so far as showing any actual conditions which arise in service.

It would be as possible to prove that a gun was not of proper strength or construction by putting in a charge several times greater than ever would be used in actual service and exploding it. Car wheels are never instantly heated by brake service, but they become gradually, and often rapidly, hot from the friction of the brakes and on long grades the heat becomes severe, but even then nothing to approximate the heat of a body of molten metal as is mentioned in your paper. As a matter of fact the conditions are almost exactly reversed from those of actual service, for in service the brake is applied cold and friction gradually heats the wheel, while in this "test" a great extreme of heat in the shape of molten metal is applied instantly and allowed to gradually cool.

The modern foundry makes car wheels to meet the requirements of the service to which they will be subjected, the same as bridge

builders have their beams and trusses of the requisite strength and electricians make their motors of the necessary power, etc.

We might as well claim that by overloading and breaking an engine that all engines of that grade and strength are faulty and dangerous as to assume that wheels subjected to a series of satisfactory tests approximating the actual requirements of service are not safe because one wheel cannot resist the strain of molten metal applied to its rim in a mass 4 inches deep and $1\frac{1}{4}$ inches wide—an amount of heat and strain that would not be applied to the wheel in actual service were it to run a hundred years.

C. V. S.

A New Railroad Club.

A railroad club is being organized in Denver whose membership will be made up chiefly of persons connected with the mechanical departments of the railroads in that vicinity. As managers and superintendents already have an organization there, the new club will do well if it will put itself in close touch with those officials, as co-operation between the officers of various departments can be thereby promoted.

Subjects to be Reported Upon at the 1897 Conventions.

Besides the standing committees on Arbitration, Supervision of Standards, Triple Valve Tests, Standard Wheel and Track Gages, and Brake Shoe Tests, the Master Car Builders' Association has appointed committees to report on: 1. Automatic Couplers. (To advise what changes may be desirable in the standard size of Master Car Builders' automatic coupler shank, and to recommend a standard yoke or pocket strap for rear attachment to car.) 2. Uncoupling Arrangements for Master Car Builders' Automatic Couplers. (To consider whether a standard uncoupling device is practicable, and the details thereof, and to recommend a device which would be applicable to the greatest number of couplers possible.) 3. Loading Logs, Poles, Bark and Long Structural Material on Cars. 4. Trains Parting. (To consider the extent and causes of break-in-twos with automatic couplers, and to suggest remedies.) 5. Passenger Car Pedestal and Journal Box for Journal, $4\frac{1}{2}$ inches by 8 inches. (To suggest designs.) 6. Specifications and Guarantee for Cast-iron Wheels. (To propose a revision of the recommended practice and to consider therewith the form of wheel.) 7. Air-Brake and Signal Instructions. (To confer with a committee from the Master Mechanics' Association and propose a revision of the code adopted in 1892.) 8. Freight Car Buffers. (To report upon experiments about to be made with improved buffers.) 9. Box-Car Side and End Doors. (To submit designs for adoption.) 10. Arch Bars and Column Bolts for Diamond Trucks. (To recommend forms in detail, for cars of 60,000-pounds capacity, and to submit designs for same for cars of 80,000-pounds capacity.) 11. Five individual reports on Designs for Steel Car Frames.

The subjects for the Master Mechanics' convention are as follows: 1. Exhaust Nozzles and Steam Passages. (Discussion of the report for 1896 is made the first order of business for 1897. Members are requested to co-operate with the committee by experimenting upon its conclusions and reporting to it.) 2. Counterbalancing Locomotives. (To designate a number of roads to confirm or disprove the recommendations in the report of 1896.) 3. Truck Swing Hangers. (The proper angle for swing beam hangers in locomotive trucks.) 4. Locomotive Grates. (For burning anthracite coal.) 5. The Apprentice Boy. (To recommend a course of shop training for apprentices, and to make recommendations in regard to their technical education.) 6. Best Metal for Cylinders, Valves and Valve Seats. 7. Boiler Jackets. (Which is the most economical, a boiler-jacket of planished iron or of common sheet-iron or sheet steel, painted?) 8. Ratios of Grate Area, Heating Area and Cylinder Volume. 9. Piecework in Locomotive Repair Shops. 10. Motors: Steam, Air and Electricity. (In a locomotive repair shop what class of work can best be performed by air motors, and what is the relative convenience and economy of air motors, electric motors and steam motors for such work?). 11. Revision of Air-Brake and Signal Instructions.

A Few Facts and Opinions on the Design of Express Locomotives.

The official report of the discussion on express locomotives at the 1895 London meeting of the International Congress has recently been published, and from it we have gleaned the following remarks by various speakers, some of which are interesting because of the information conveyed, while others serve to show the lack of information on the details of American practice existing in Europe.

Mr. Aspinall, in speaking of crank axles, said: "I am very often asked by American engineers, how long these crank axles last? I have not given any figure in the paper, and I would mention that a great many erroneous views seem to exist on this point. It so happens that in this country we have to make returns to our Board of Trade of all axles which break in service, and not the axles which are taken out in the workshops by reason of a flaw. The result is, that a certain number of figures exist at the Board of Trade which show that a certain number of axles have broken after, perhaps, having run a comparatively short time, and those figures are published. As a consequence, people often infer that the life of a crank axle is very short. This is quite a mistake. It is shorter than people would like, no doubt, but we have many axles running 400,000 miles. I have had a number which have run up to 600,000 miles, which were taken out when the engines were rebuilt, and, had it not been that they were of an old pattern, would have been good for further service. It is, I think, desirable to lay stress upon this point, because our Board of Trade, and others who write in some of the technical journals, have an idea that when axles have run, say 200,000 miles, they ought to be taken out and condemned."

In discussing counterbalancing, Mr. Webb, of the London & Northwestern, was asked for his rule for determining the weight of the balances, and replied as follows: "In the case of non-compound engines we put weights in the driving wheels equal to half the weight of the reciprocating parts, plus the whole of the weight of the revolving parts. In our compound engines, for the high-pressure wheels, we use the same rule as above, but in the low-pressure wheels we put weights equal to the whole of the revolving and reciprocating parts combined, and we find that this practice gives very satisfactory results in the steadiness of the engine. The weights so obtained are not excessive."

On the subject of the use of leading trucks, Mr. Worsdell, of the Northeastern Railway, gave the practice of his road as follows: "We use the bogie principle entirely for our express engines now, because I found out in actual practice that it gives the drivers very much greater confidence in running if they have a four-wheeled truck in front. Unfortunately, the North Eastern Railway has a number of curves, and most of our main-line stations are on curves, and it is a very difficult matter to start away from these stations, especially at Newcastle, where we have a reverse curve to contend with, and I am very strongly in favor of the bogie principle for express engines. The express engines on the North Eastern Railway run at very high rates of speed with some of the trains, and whereas I found that with the same class of train with an express train having a single pair of wheels in front our men were in the habit of losing time, I also found out from the men themselves that they did not like to run at a high rate of speed owing to having a single pair of wheels only in front."

On the same subject, Mr. Baudry, of the Paris-Lyons-Mediterranean Railway, said: "Formerly our express locomotives used to have no leading bogie, but we cannot well compare them with our present engines because the patterns are by no means similar. In our new engines the weight is more concentrated toward the middle, and on the other hand their wheel base is longer. They are also much easier on the road, but this improvement cannot be attributed to the use of a bogie. In order to test the effect of a bogie, the two first locomotives of this pattern were built one with a bogie and the other with a simple carrying axle, but otherwise exactly similar. I must confess that the engine without a bogie was at least as easy upon the road as the one with a bogie, besides being a little lighter and simpler in construction. Nevertheless,

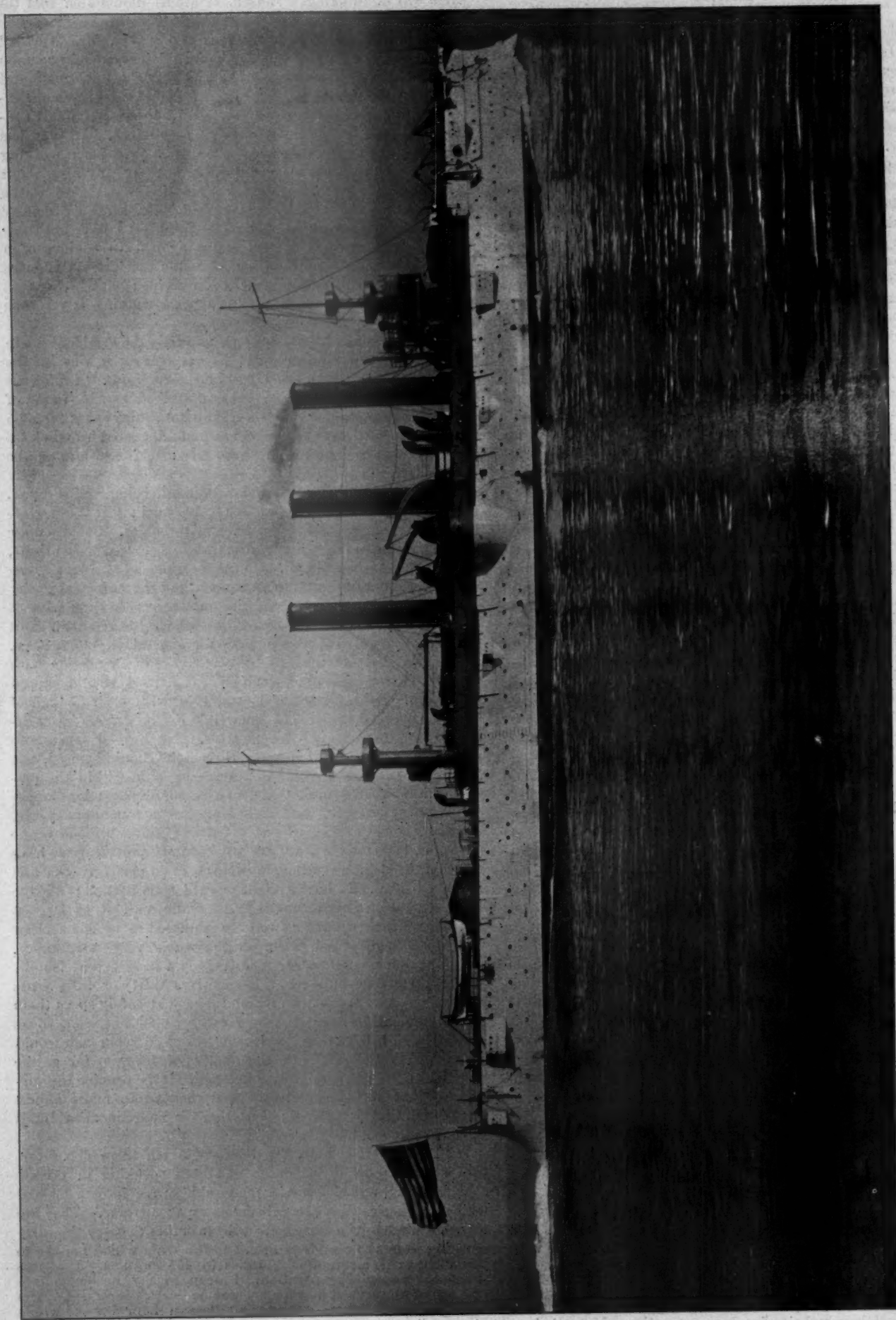
I myself declared in favor of the bogie and my company is of the same way of thinking. Indeed, it seems indubitable that the bogie is safer."

In reply to a question about balanced valves, Mr. Worsdell said: "I do not think we have had sufficient experience upon our North Eastern line to give you any valuable information at present upon the subject of the balanced slide valve. We are experimenting with balanced valves, and I am now building 10 engines and putting on the piston valve to engines, but that has been done so very recently and the engines have been working for so few months that we would rather not say anything about them on this occasion. I might just mention with regard to the piston valve that although we have only had some six months' experience in the working of these engines, yet I have put these five engines working in express trains against 10 engines of a similar class and the consumption of fuel in the last six months has effected something like 10 per cent. saving; but whether that will be carried out in the whole 12 months' running is yet to be seen."

At the close of the discussion on slide valves the President made a remark that will read strangely to our readers in view of the widespread use of balanced valves here. He said: "I think we all agree that if a simple and practical method can be found of applying balanced slide valves we shall not refuse to try them on our engines. All that is required is to find a simple and cheap method which will not complicate the machinery, and not be extravagant to maintain."

Mr. Ely, of the Pennsylvania Railroad, being called upon, made this statement of the practice on his road: "It is our practice to build our express locomotives with bogies. Usually these locomotives have two pairs of drivers and a four-wheeled bogie, making eight wheels in all. On the portions of our lines where the passenger trains are not frequent and the trains are very heavy, we use, to some extent, locomotives with three pairs of drivers, making what we term a ten-wheeled locomotive. But we do not approve of this practice for general express service. We believe that the work to be done, taken in connection with the allowable weight upon each pair of drivers, should suggest the design. For light trains locomotives with a single pair of drivers should be prepared if the weight on the drivers is not excessive; we have no such locomotives. For heavier trains two pairs of drivers; for still heavier, three pairs should be used, and so on, always keeping the weight on each pair within the prescribed limits. We think that every pair of drivers adds complications of machinery and friction. For a number of years, especially since pressures up to 200 pounds have been in vogue (on some locomotives we carry 210 pounds pressure), we have felt that the Belpaire principle secures to us perfectly safe and reliable boilers. It is a straightforward construction; all the bolts, etc., are at right angles; and while with it as large a heating surface cannot as well be obtained as by some other forms, we have found them on the whole very satisfactory. As to the question of speed, very little can be said that is new. Unfortunately the builders of locomotives thirty or forty years ago did not have track upon which they could safely speed them—else, I am afraid, our present records would not seem so remarkable. I believe that the locomotive of 30 years ago would probably travel as fast as the locomotive of 1895, so far as the principle of construction is concerned. It is possible for any railroad that has a sufficiently good roadbed to make almost any speed that is desired; but there is an economical limit which should not be exceeded."

The President asked Mr. Ely if he would tell them about certain express trains of which he had been speaking in private shortly before, and Mr. Ely in reply said: "We have a class of trains in America that are called 'newspaper trains.' They are leased or hired by the great metropolitan dailies to carry the early morning papers to seaside resorts, and the train which I spoke to you about made a run of 58 $\frac{1}{2}$ miles in 45 $\frac{1}{2}$ minutes. That was without any special preparation. I mean to say the locomotive was one of those used in regular service on these trains. The average speed is between 76 and 77 miles an hour for the whole distance."



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The United States Armored Cruiser "Brooklyn" as it Appeared on its Official Trial Trip, August 27, 1886.—Speed, 21 9117 Knots per Hour.

Built by the Wm. Cramp & Sons Engine and Ship Building Co. of Philadelphia, Pa

The United States Armored Cruiser "Brooklyn."

On Aug. 27, the United States armored cruiser *Brooklyn* underwent a very successful trial trip off the Massachusetts coast, developing an average speed of 21.9117 knots per hour over the entire course of 83 miles and reaching a maximum of 22.90 knots, which was maintained for some miles. By this performance the vessel takes a position at the head of her class among the navies of the world, and also earns a premium of \$350,000 for her builders, the Wm. Cramps & Sons' Ship and Engine Company, of Philadelphia. It is to be noted that during the trial trip the machinery worked so well that no heating or cutting of bearings took place.

In the full-page engraving accompanying this article we give a view of the vessel taken during the trial trip, and in Fig. 2 we show two half cross-sections through the engine rooms. The length of the cruiser on the load water line is 400.5 feet, the extreme beam 64.68 feet, mean normal draft 24 feet, normal displacement 9,271 tons, displacement on trial 8,150 tons. The indicated horse-power of the engines is placed at 16,000, the normal coal capacity 900 tons and the total coal capacity 1,753 tons. The contract called for a speed of at least 20 knots with a premium of \$50,000 for each one-quarter knot in excess of that figure.

The boat is propelled by two screws, each driven by two triple-expansion engines, making four engines in all, each placed in a separate water-tight compartment. The object of this division of the propelling power into four units, is to provide for a reduced engine power for ordinary cruising with more economy than is possible when running large engines at half power. For such cruising the forward engines will be disconnected at shaft couplings provided for the purpose, and the two after-engines will turn the screws. They will then work with practically full power and consequently with economy. Each engine has a high-pressure cylinder 32 inches in diameter, one intermediate 47 inches and one low-pressure cylinder 72 inches in diameter. The stroke of all pistons is 42 inches.

The engines were calculated to make 129 revolutions per minute when generating 16,000 horse-power. The engines are placed in the boat with the high-pressure cylinders forward. The main valves are all of the piston type, there being one for the high-pressure, two for the intermediate, and two for the low-pressure cylinder. The intermediate and low-pressure cylinders are steam-jacketed. The engine frames are of cast steel and of the inverted Y form. The bed plates are also of cast steel and are supported

on wrought-steel keelson plates. The crank shafts are each in three sections. All shafting is hollow. The after-section of each propeller shaft is of nickel steel, 17 inches in diameter, with a 11-inch hole through it, except at the propeller fit, where the thickness of metal is nowhere less than 4 inches. The thrust shafts are of mild steel, 16½ inches diameter, with a 7½-inch hole through them. There is one condenser for each engine, with a cooling surface of about 5,681 square feet. The main circulating pumps are of the centrifugal type, one for each condenser. The air pumps are independent, double-acting, horizontal, two for each engine. In each after engine room there is an auxiliary condenser of sufficient capacity for one-half of the auxiliary machinery.

The steam is supplied by five double-ended main boilers and two single-ended boilers (used either as main or auxiliary boilers) of the horizontal-return fire-tube type. They are 16 feet 3 inches outside diameter and four of the double-ended boilers are 18 feet long, the fifth 19 feet 11½ inches long, while the two single-ended boilers are each 9 feet 4½ inches long. The boiler pressure carried is 160 pounds. The boilers are arranged in three water-tight compartments. The total grate area is 1,016 square feet, and the total heating surface 33,353 square feet.

The forced draft is on the closed stokehold system, and the air is furnished by two Sturtevant blowers for each fireroom. Blake pumps are used for nearly all water-pumping purposes throughout the ship except at the evaporators, where Davidson pumps are installed.

The hull of the vessel is of steel, not sheathed, with a double bottom and close water-tight subdivision, carried up to about 12 feet above the water line. The arrangement of decks above water provides an unusual freeboard and berthing accommodations. It will be noticed from the full-page engraving that there is one more deck forward than aft. There are two military masts with fighting tops. The boats are stowed clear of the blast of the guns, but two life boats are so carried that they may be readily lowered under all conditions of weather.

The hull is protected by means of a steel protective deck worked from stem to stern and supported by heavy beams. The edges of this deck, amidships, are 5 feet 6 inches below the 24-foot water-line, the top of the deck rising to this water line at the center of the vessel. On the slopes over the machinery and boilers the deck is 6 inches thick; on the horizontal portions it is 3 inches thick; forward and abaft the machinery and boilers, to stem and to stern, the deck is at the thinnest part not less than 2½ inches

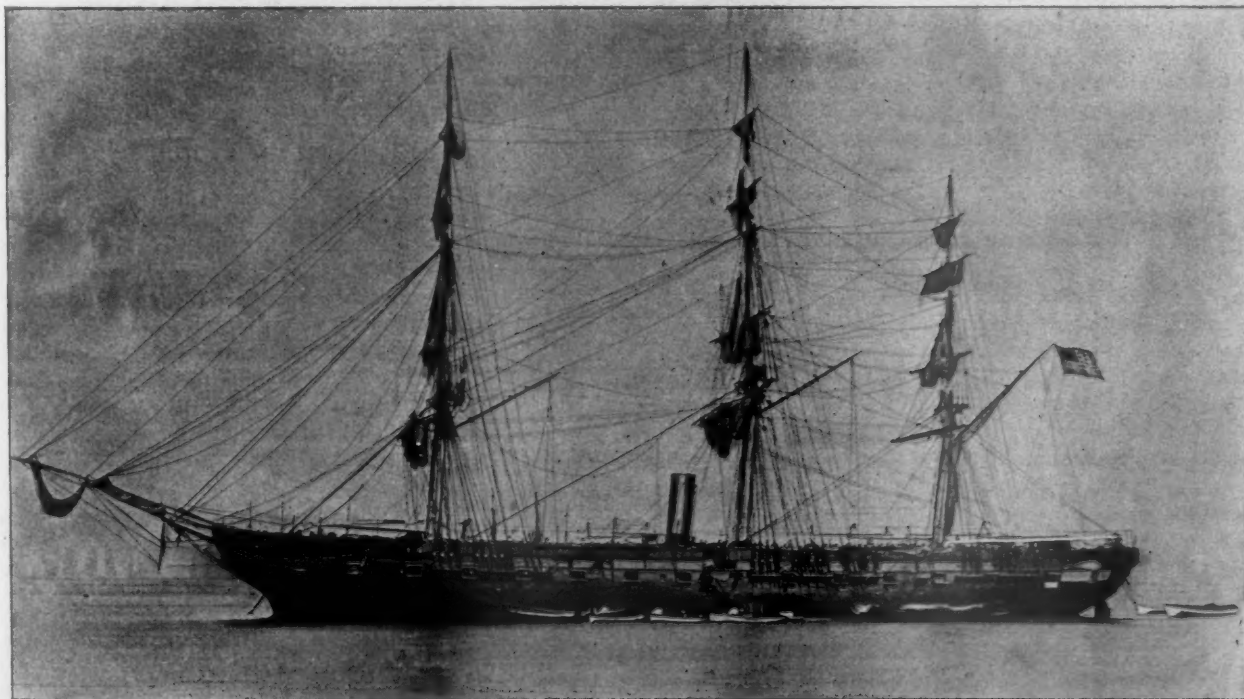


Fig. 3.—U. S. Sloop-of-War Brooklyn—Built 1858.

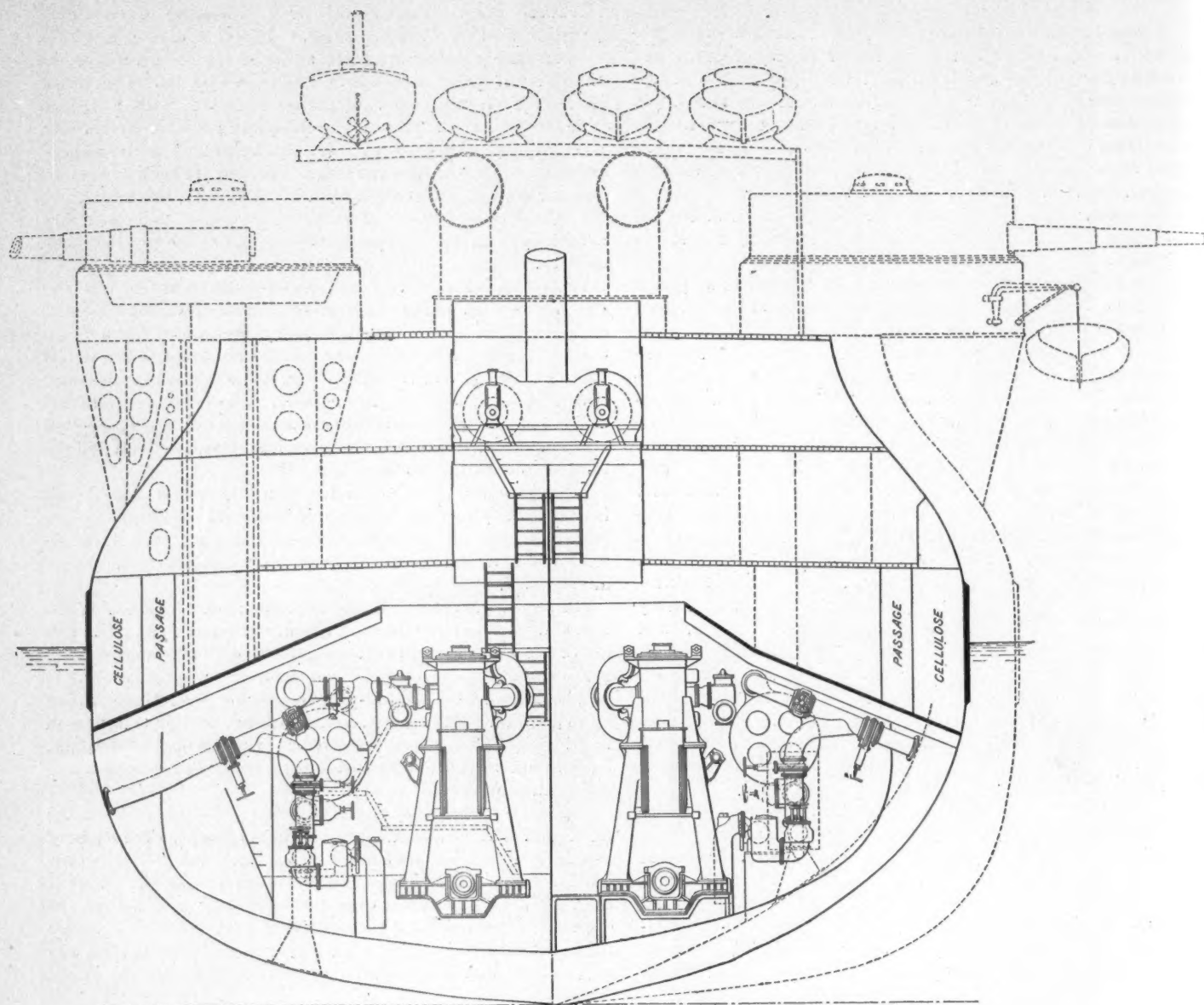


Fig. 2.—Sections of the United States Armored Cruiser Brooklyn.

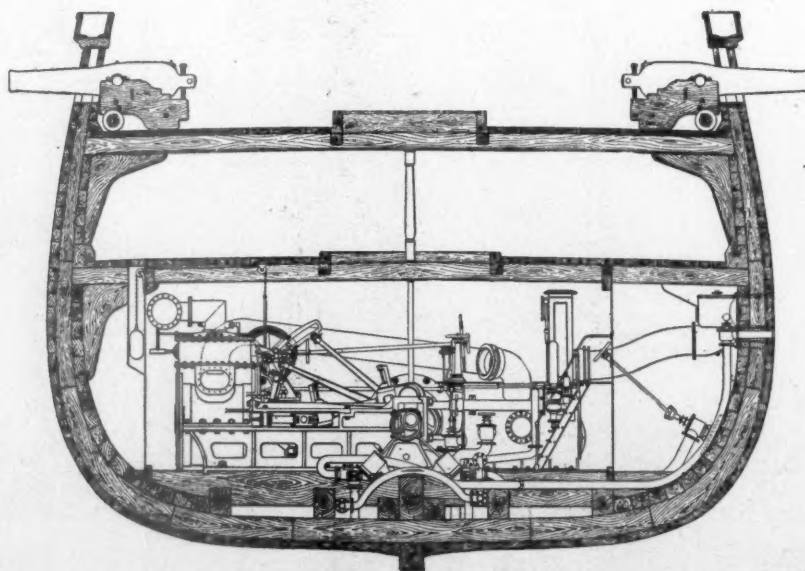


Fig. 4.—Section of the U. S. Sloop-of-War Brooklyn, Built in 1858.

in thickness. Below this deck are placed the propelling machinery, steering gear, magazines, shell rooms, and all that is ordinarily styled "the vitals of a warship."

Protection of the hull from injury to the water-line region is afforded by means of an armor belt 3 inches in thickness, extending the length of the machinery and boiler space, and in depth from 4 feet above the 24-foot water-line to 4 feet 3 inches below it. On the inside of this armor belt and skin plating is a backing of cellulose $3\frac{1}{4}$ feet thick, extending the whole length of the vessel and from the armor deck to the berth deck.

Coal is carried above the armor deck for a length corresponding to the inner bottom, this space between the armor deck and the deck above being subdivided by water-tight bulkheads into 38 coal-bunkers, exclusive of cofferdam and passages. The space forward and abaft these bunkers is subdivided for stores.

A conning-tower 8 inches in thickness stands in a commanding position, having a tube to the protective deck 5 inches in thickness for the protection of speaking-tubes, bell wires, etc.

The battery of the vessel comprises eight 8-inch B. L. R. of 35 calibers, twelve 5-inch B. L. R. rapid-fire guns, twelve 6-pounder rapid-fire guns, four 1-pounder rapid-fire guns, and four machine guns. The 8-inch guns are mounted in four barbette turrets, placed one forward and one aft on the center line of vessel, and one on either side amidships. The guns in the turrets on the center line of the ship have a train of 310 degrees; those in the side turrets fire from right ahead to right astern or train through an arc of 180 degrees each, and it was partly to obtain this desirable feature that the sides of the hull were given the "tumble home" so noticeable in Fig. 2. Thus six 8-inch guns can be trained simultaneously in any desired direction. The centers of the side turrets are distant from the center line of the vessel about 23 feet. The armor forming the barbettes, which will protect the carriages, platforms and turret machinery are 8 inches in thickness for a portion at least equivalent to the train of the guns of the respective turrets, the remaining portions being reduced to 4 inches in thickness. Under the turrets there will be placed 3-inch armor supporting tubes which will also protect the ammunition hoist. The armor of the turrets is $5\frac{1}{4}$ inches in thickness.

The 5-inch guns are protected by fixed segmental shields 5 inches in thickness. The crews of these guns are further protected from explosive shells by splinter bulkheads $1\frac{1}{4}$ inches in thickness. Protection is afforded the smaller guns by shields and extra side plating.

The forward and starboard turrets of the ship are operated by electricity, and the port and aft turrets by steam. As this is the first time that electricity has been used for this purpose in the United States Navy, the operation of the electric machinery for the turrets will be watched with interest.

The torpedo outfit consists of five torpedo tubes, one in the bow and two on each side, six Whitehead torpedoes and a suitable allowance of gun-cotton for mines and miscellaneous purposes.

Distilling apparatus and evaporators supply fresh water, the capacity of the evaporating plant being 10,000 gallons per day. A one-ton Allen ice machine is also installed on the boat.

The electric current for lighting is supplied by three dynamos, and a fourth supplies the current for operating the turrets. The steam steering gear is novel in that it is electrically controlled, that is, the connections to the steam steering engines from the conning-tower are electrical, not mechanical.

The ship will have a radius of action at full speed of 1,758 knots, and a radius of action at 10 knots of 6,088 knots. The complement of officers and men will be 561 persons.

The many steps in the advancement of marine engineering and naval construction have followed each other so closely in the last few decades that few of us stop to think of how much has been accomplished in a short time. To illustrate the rapidity of this progress we have reproduced, in Figs. 3 and 4, a photograph and cross-section of the old United States sloop-of-war *Brooklyn*, these engravings being on the same scale as those of the new *Brooklyn*. In Fig. 2 the engines are shown as they appear looking aft, but we have added in dotted lines the amidship turrets, guns, etc., also the amidship section to make possible a comparison with Fig.

4. A correct idea is therefore obtained as to the relative size of the two boats, and their cross-sections also give a somewhat imperfect idea of the difference in the magnitude of the propelling machinery. In comparing the two cross-sections the reader has to bear in mind that there are twice as many engines on the new *Brooklyn*, as seen in Fig. 2; there are also seven boilers on the new, as against three on the old, to say nothing of electric-lighting plants, refrigerating and evaporating machinery, turret-turning engines, hydraulic machinery, steam steering apparatus, etc., etc., none of which were to be found on board men-of-war built 40 years ago.

The old *Brooklyn* was built in 1858, and cost \$417,921. It had auxiliary steam power in the shape of a double horizontal engine driving a single screw. The steam cylinders were 61 inches in diameter and 33 inches stroke. The principal dimensions were as follows: Length between perpendiculars, 233 feet 4 inches; breadth, 43 feet; mean draft, 19 feet 6 inches; displacement, 3,000 tons; indicated horse-power, 1,116; speed, 10 knots; coal capacity, 300 tons. Complement: Officers, 23; men, 268; total, 291.

After a most creditable career the boat was sold in 1891 for \$13,128.

A brief study of the two sets of engravings accompanying this article will not only impress upon any thoughtful person the great changes introduced in less than 40 years into naval warfare by modern guns and armor and by the use of steam for the propelling power, but ought to convince every reader in an equally impressive manner of the reliance which must be placed upon the engineer officers in designing, building and operating these modern vessels. The engineer, though at present not accorded his proper status in official circles, is the leading spirit in all this work. Without him such marvelous vessels could not be built, and if built could not be operated for a single day.

We are indebted to Commodore Melville, Chief of the Bureau of Steam Engineering, U. S. N.; Commodore Hichborn, Chief of the Bureau of Construction, U. S. N., and Mr. W. H. Ross, of Philadelphia, for the drawings and photographs from which our engravings were made.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.

BY OSCAR ANTZ.

(Continued from page 217.)

FREIGHT TRUCKS—(CONTINUED).

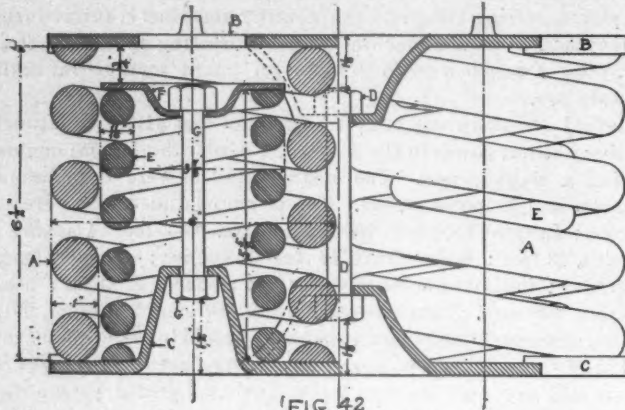
To relieve the body of the car from shocks due to running over rough places in the track, springs are introduced between the spring-plank and the truck bolster. Steel springs, both of the coil and the elliptic pattern, are used for this purpose; the use of the latter is, however, almost entirely confined to live stock and other cars on which it is desired to obtain a more than usually easy motion. The bolster springs are placed as nearly as possible on the line of the archbars, so as to relieve the spring-plank of undue strains, and they are kept in place by being set in pockets which in their turn are fastened to either spring-plank or truck-bolster, or merely rest on the former, dowels or lugs being provided to prevent their displacement.

Spiral springs are usually arranged in groups, varying in number from three to six, or even more springs to each group, four being the usual number for modern cars. The springs are of such capacity that they are slightly compressed with the weight of the car body empty, and the total capacity is somewhat in excess over the pressure that can be brought to bear on each spring when the car is fully loaded. Single coil springs are generally used for each member of the group and the diameter of the steel from which they are made varies from $\frac{3}{4}$ to $1\frac{1}{4}$ inches, 1 inch being the usual size. Springs made from steel, the section of which is not a circle, are used somewhat, but very little on recently built cars. The diameter of the bolster springs usually runs from 5 to 6 inches and their length from 6 to 7 inches, where four spring are used to each group.

With the modern large cars, the load which can be carried is about twice the weight of the car or over three times the weight of the body alone, and the compression of the springs is there-

fore considerable when the car is loaded, if the spring is light enough to give an easy motion when the car is empty.

To obtain a spring which has a minimum resistance under a light weight and a much larger one under a heavy load, two coils can be used for each member of the group, the inner coil being made shorter than the outer one, so that it will not be under any strain until the outer coil has been compressed a certain amount,



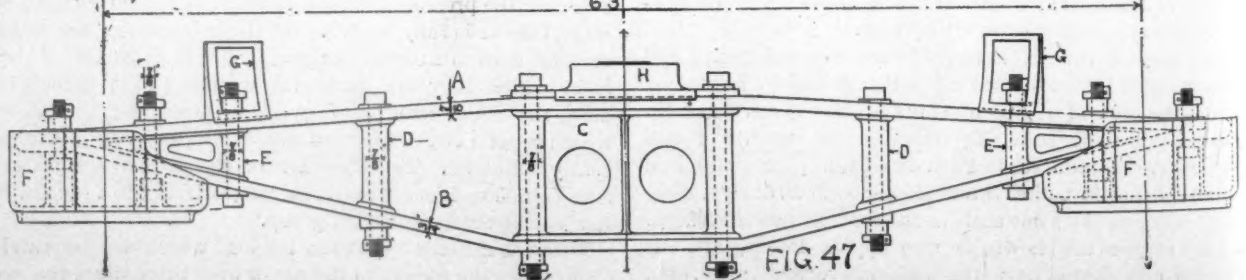
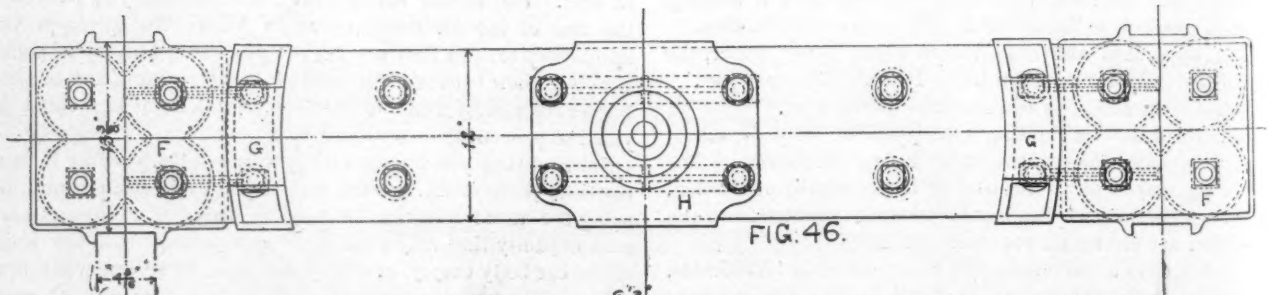
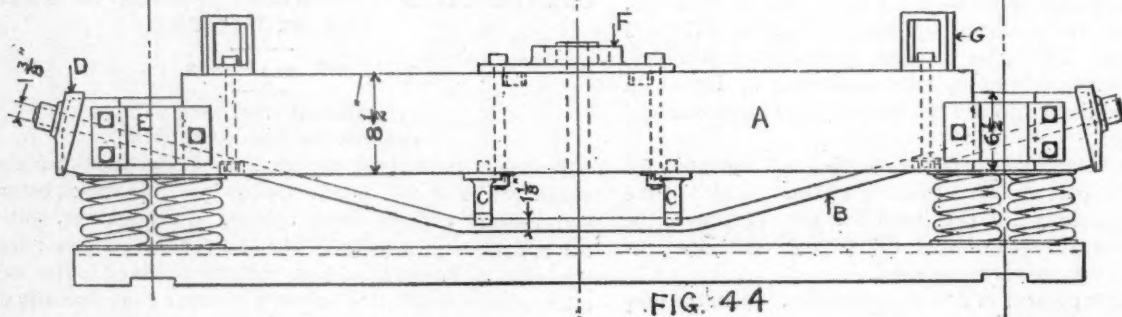
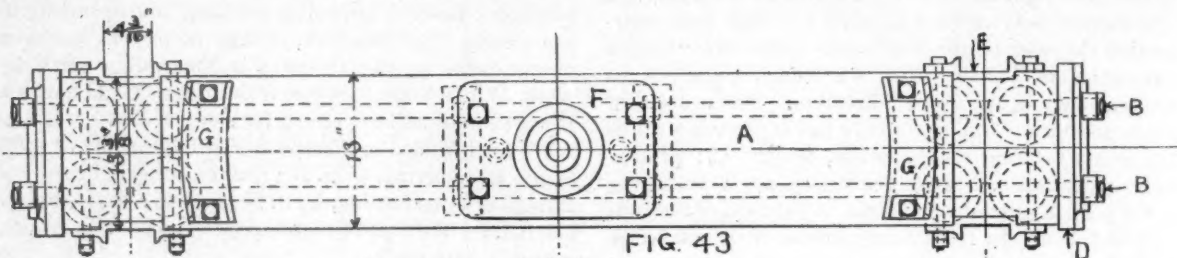
say slightly over the compression due to the weight of the car body alone.

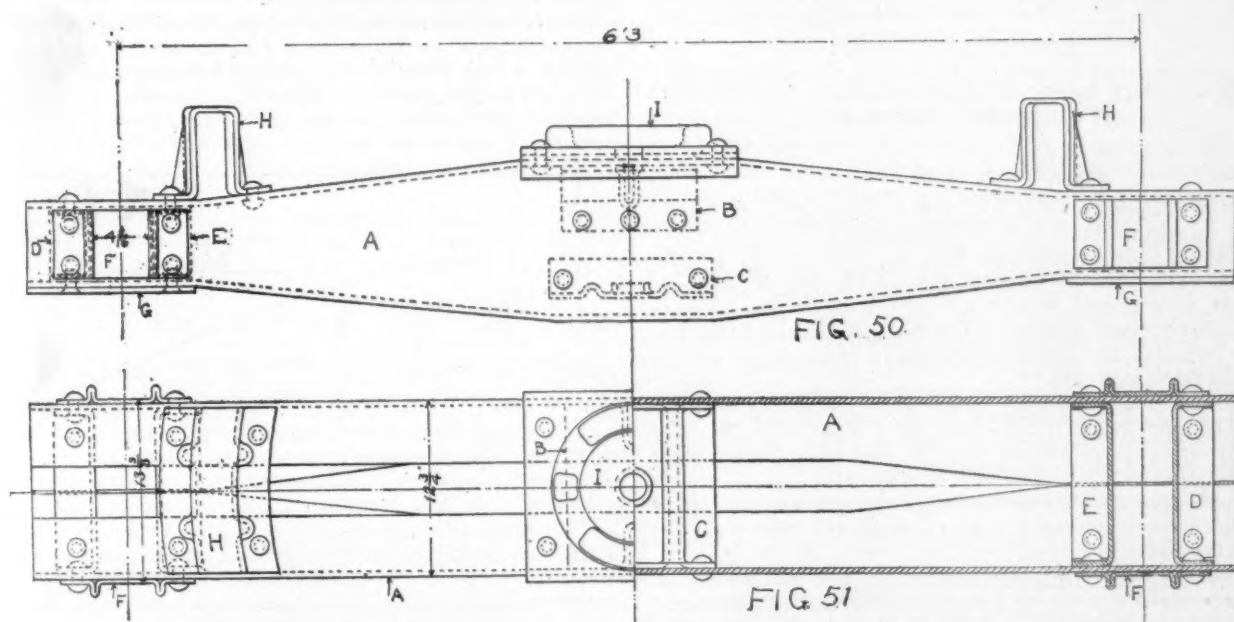
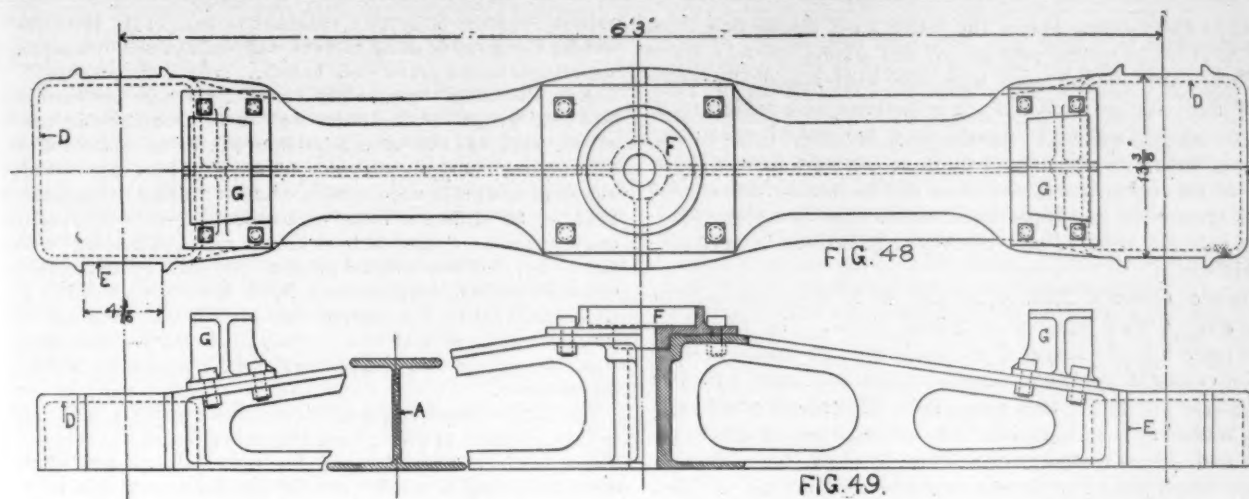
Such a spring is shown in Fig. 42, where A A are the outer

coils, 6 inches in diameter and 6 inches long, made of 1-inch diameter steel wire; there are 4 springs to a group, which are held in place by the two malleable iron or pressed steel plates, B and C, which are fastened together by the bolts and nuts, D D. The inner coils, E E, are 3½ inches in diameter and 5½ inches long, made of 1½-inch steel, and held between the lower spring plate, C, and cap, F, by means of the bolt, G. As will be seen, this spring will be compressed against the resistance of the outer coil alone until the cap F strikes the upper spring-plate B, when the inner coil comes into action, as well as the outer one, increasing the resistance of the spring about double. In designing a spring like this, care must be taken that the bolts D and G are short enough so that they will not interfere with the spring being compressed to its full capacity.

TRUCK BOLSTERS.

Until very recently, wood was almost the only material used for truck bolsters of freight cars, but with the extensive introduction of iron in car construction, it has almost superseded wood for this purpose, at least on a number of large roads. Iron was first introduced into truck bolsters in the shape of plates inserted into the bolster, or bolted between the several parts into which it was cut, forming the so-called sandwiched or composite bolster, one great objection to which is that the wood shrinks and leaves the bolts loose, thereby making the bolster weaker perhaps than one of all wood. More recently arches of





flat bars, steel castings and pressed steel have been used respectively for truck bolsters; and these will be described individually.

There is more or less diversity in the details of wooden truck bolsters, the cross section being the same on hardly any two roads, some using one solid piece of wood, some two pieces bolted together, and others again introducing flat plates, channel bars or I-beams, those without any iron stiffeners being trussed by rods. Figs. 43, 44 and 45 show a good form of the latter, which will fit the truck frame illustrated in the last issue. The bolster *AA* is made of oak, 8½ by 13 inches in section, and is cut down to 6½ inches deep at the ends, where it projects through between the arch bars and column guides. It is trussed by means of truss-rods *BB*, 1½ inches in diameter, with the ends enlarged to 1¾ inches. The rods are bent to shape and then inserted in place through slots cut in the bottom of the bolster, which are filled up by pieces of wood, after the rods are in place. On the lower side of the bolster the rods pass under cast-iron posts *CC*, about 4 inches high, two to each rod; the ends of the rods pass through washers *DD*, which cover the ends of the bolster and take both rods. These washers are made of either cast or malleable iron or pressed steel.

To each side of the bolster at each end are bolted the bolster guide blocks *EE*, by means of three ¾-inch bolts, passing through the bolster and having double nuts. The bolster is guided out to receive the raised part of this casting, the corresponding depressed part working over the column guide bar, and keeping the bolster from moving laterally.

The truck center plate *FF* is bolted to the bolster by means of four ¾-inch bolts, and is provided with lugs or dowels and some-

times with flanges on its side to prevent its displacement and to relieve the bolts.

Different styles of center plates are in use which were explained, under the head of body bolsters.

The side bearings *GG* are made of proper height to allow a space of from ¼ to ½ inch between the body and truck side bearings when the car is empty and on a straight track, and are fastened to the bolster by means of two ¾-inch bolts. Other styles of side bearings are in use, which have already been described under the head of body bolsters.

In Figs. 46 and 47 is shown a truck bolster made of bars of flat iron bent to form a truss. *A* and *B* are the upper and lower bars, made of ¾ and ¾-inch iron respectively, each being 12 inches wide. The bars are bent as shown, and are tied together by ¾-inch bolts passing through malleable iron distance pieces *C*, *D* and *E*; some of these bolts are also utilized to hold the centreplate and side-bearings. The lower bar is upset on the ends, forming lugs for the upper bar to bear against. There is considerable strain on the bolts in this construction, and it has been found necessary to make the fit in the holes a good one to prevent their breaking. The two bolts in the outer ends should be turned and driven in.

The ends of the bolster are provided with malleable castings *FF*, paving flanges which guide the bolster in its vertical motion on the bolster column, and also have pockets on their lower sides for the bolster springs to rest in. Side bearings *GG* and center *H* are provided as usual.

Cast steel is used to some extent for truck bolsters, and the cross-sections having the maximum strength for the minimum weight are adopted, which are the channel bar and the I-beam sections,

Figs. 48 and 49 showing one of the latter kind, the section being shown at A. The spring pockets *DD* and guides for the column bars *EE* are cast in one piece with the bolster and the center plate *F* and side bearings *GG* are sometimes also made part of the same casting, although usually they are bolted on, so that their height may be adjusted when it is necessary to change the height of the car. The center plate shown has a hub on the bottom, around the center-pin hole, which rests in a corresponding recess in the bolster, and thereby relieves the bolts of considerable strain.

The bolster shown in Figs. 50, 51 and 52 is made entirely of pressed steel, riveted together by 4-inch rivets. The two sides *AA* are pressed in the shape of channels and are connected by means of center braces *B* and *C*, and end braces *DD* and *EE*. The bolster guide blocks *FF* are also made of pressed steel and riveted in place. A spring plate *GG* is riveted on the lower side of each end, where it rests on the bolster springs. Side bearings *HH* and center plate *I* of pressed steel are also riveted on and assist to tie together the two sides of the bolster.

(To be Continued.)

The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers.*

BY PROF. W. F. M. GOSS.

The experiments with which this paper is concerned were carried out a few months ago in the locomotive laboratory of Purdue University. They are here presented by a brief and very general description of the work, together with a discussion of some of its most significant results, and by two appendices which give the more technical descriptions, Appendix I dealing with the apparatus and methods employed, and Appendix II giving a summary of all observed and calculated data.

The problem to be studied by means of the experiments will be more readily appreciated if it is remembered that the boiler of any given locomotive is most efficient when worked at the lowest power practicable; that, is when the rate of combustion in its firebox is minimum. For the development of a higher power, the rate of combustion must be increased, and, as a result, the efficiency of the boiler is lowered.

The relation between the rate of combustion and the weight of water per pound of coal for the Purdue locomotive "Schenectady," while using Brazil block coal, is shown by Fig. 1.† From this diagram it appears that when coal is burned at the rate of 50 pounds per square foot of grate per hour, eight pounds of water are evaporated for each pound of coal; while if the rate of combustion is increased to 180 pounds per foot of grate, the evaporation falls to about five pounds—a loss in water evaporated per pound of coal of nearly 40 per cent. This loss may be due to a failure of the heating surfaces to absorb properly the increased volume of heat passing over them, or to the imperfect combustion of the fuel upon the grate, or it may be due to a combination of these causes.

That a portion of the loss occurs along the heating surfaces hardly admits of question, since it is well known that any increase in the rate of combustion results in a rise in the temperature of the smokebox gases; but whether, under ordinary conditions, any considerable portion of the loss shown by Fig. 1 is due to imperfect combustion, has not been demonstrated,‡ and it is this question especially that the present paper attempts to treat.

The importance of the subject is emphasized by the varying practice of locomotive designers, who, in some cases, have so designed large boilers as to allow a large grate, while in others they have been content to use a grate of moderate size, upon which they have forced the combustion beyond limits which had hitherto been customary.

It will be seen that a separation of the losses which may occur at the grate from those which take place along the heating surface could not be accomplished by boiler tests alone, because the results of such tests give the combined effect of both these losses. There are two variables involved, and in order that either may be deter-

mined one must be given a constant value. In the tests described, action along the heating surface was maintained constant, while conditions at the grate were varied.

As a preliminary step, a number of tests were outlined in which the total weight of fuel fired was to be constant throughout the series, while the rate of combustion was to be made different for each test by changing the area of grate. It is evident that if the action at the grate were equally efficient during the several tests—that is, for different rates of combustion—this provision would cause the same volume of heat to pass over the heating surfaces of the boiler, and hence would produce the same evaporation and the same smokebox temperature. If, on the other hand, the combustion should prove less efficient for any one test than for others, a smaller volume of heat would sweep the heating surface, less water would be evaporated, and the smokebox temperature would probably be lower.

The outline provided for all observations usual in boiler testing, and, in addition to these, for a determination of the weight of fuel lost in the form of sparks, and for chemical analyses of the fuel used, of the sparks caught and of the smokebox gases. A more complete description of the apparatus used and the methods employed will be found in Appendix I.

The first test was run with the locomotive under normal conditions. The whole grate was covered with fuel, the throttle was fully open, the cut-off approximately 6 inches, and the load such as to make the speed 25 miles per hour. These conditions gave a rate of combustion of 61 pounds of coal per square foot of grate per hour.

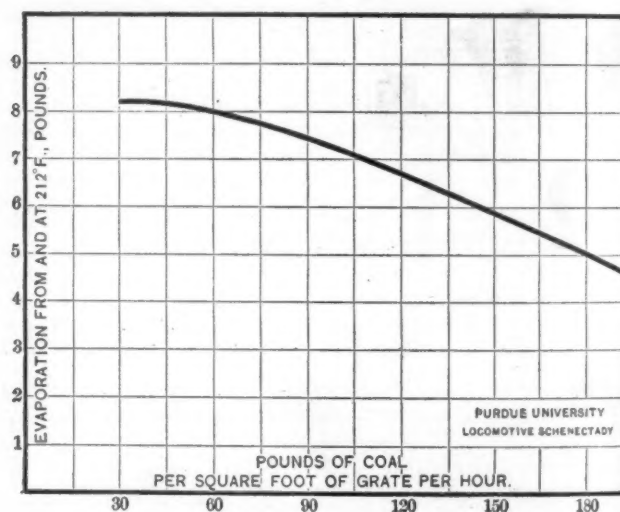


FIG. 1.

In preparation for the second test, one-quarter of the grate was made non-effective, or "deadened" by a covering of fire-brick. The exhaust tip was reduced, so that, while the engine was running as before and using approximately the same amount of steam, the same total weight of fuel could be burned on the reduced grate as in the first test had been burned on the whole grate. Trial tests were run until it was known that the changes made would permit the desired conditions to be maintained. The rate of combustion in this test was 84 pounds per square foot of grate area.

In preparation for the third test, the grate surface was reduced to half its original area, and the rate of combustion was increased to 124 pounds per square foot of grate area; and during the fourth test only one-quarter of the original grate was used, the combustion in this case rising to 241 pounds per square foot of grate surface.

It should be evident from what precedes that the prescribed conditions were designed to make each test a duplicate of every other test, excepting in the matter of grate area, this being the one variable for the series.

The coal used in the several tests was of uniform quality, the chemical analyses (Appendix II.) showing no greater variation than might occur in different samples from a single shipment. The maximum weight of coal fired per hour in any test was 1,087 and the minimum was 1,033, a difference of less than 50 pounds in more than 1,000, while the variation during three of the four tests does not exceed 1.2 per cent. of the weight fired. All firing was done by one man, the attendants engaged in taking the more important observations were the same for all tests, and

* From a paper read before the New York Railroad Club Sept. 17, 1896.

† Fig. 1 is reproduced from the Proceedings of the Western Railway Club, 1895.

‡ This question has been very ably discussed by Mr. W. H. Marshall, in an editorial which appeared in the January (1896) number of the *Railway Master Mechanic*.

all external conditions affecting the action of the boiler were uniform throughout the series.

The one variable for the series—namely, a different rate of combustion, was secured by keeping constant the weight of coal fired and by varying the area of the grate. There were burned each hour on each square foot of effective grate surface, 61 pounds during the first test, 84 during the second, 124 during the third and 241 during the fourth. These values more than cover the entire range of rates usual in locomotives.

Evidence of losses at the grate with increased rates of combustion is to be found in the record of water evaporated per pound of coal, which, for the several tests, is as follows:

1. Number of test.....	1	2	3	4
15. Rate of combustion; pounds of coal per foot of grate surface.....	61	84	124	241
50. Equivalent evaporation from and at 212 degrees Fahr.; pounds of water per pound of coal.....	8.26	7.87	7.52	6.67
Loss of evaporation in terms of the evaporation for test No. 1.....	....	4.7	9.0	19.2

In consideration of all the conditions governing the experiments, it would seem fair to assume that the decrease of 19 per cent. in the weight of water evaporated, a result which comes from increasing the rate of combustion from 61 to 241, is a loss which occurs wholly at the grate.*

The preceding paragraph exhibits a measure of the loss which occurred at the grate of the boiler tested, when the rate of combustion was increased above 61 pounds. A large fraction of this loss is to be accounted for by the escape of sparks, and it is significant that, as the sparks increase in volume, their heating value also increases. (Item 34.)

By reducing the weight of sparks to an equivalent weight of coal, on the basis of their relative heating value, it is possible to make the following comparison:

1. Number of Test.....	1	2	3	4
15. Rate of combustion.....	61	84	124	241
14. Total pounds of coal per hour.....	1,074	1,078	1,086	1,038
Total pounds of sparks per hour.....	61.5	95.1	128.6	176.3
Pounds of coal equivalent to spark losses per hour.....	46	77	111	161
Value of spark losses in per cent. of coal fired.....	4.3	7.2	10.2	15.5

According to popular judgment, the loss of heat by sparks has always appeared small; while the data show that under conditions which are now common, it may represent more than 10 per cent. of the fuel value of coal fired. It is evident, however, that these losses will in general depend very much upon the quality of coal and it should be noted that the Brazil block which was used in the tests under consideration is quite friable.

Without attempting a full discussion of the analyses of the smokebox gases (Items 37-41), attention may be directed to two important facts. These are, first, the large percentage of oxygen shown, indicating a supply of air greatly in excess of that required for combustion; and, secondly, the absence of carbon-monoxide (CO) in all excepting the last test.

All air admitted to the furnace in excess of that required for combustion is heated from the temperature of the atmosphere to that of the smokebox, and by this process heat is taken from the furnace. As the data show an increasing amount of air during the third and fourth tests of the series, it would appear that this cause must have operated to reduce the performance of the boiler as the rate of combustion was increased.

The presence of carbon-monoxide (CO) in the smokebox gases is accepted as proof of imperfect combustion. This gas, as already noted, occurs only in Test No. 4. It has long been supposed that its formation is due to thick firing, and its failure to burn after it is formed to deficient air supply, or to a temperature too low to ignite it. Upon this theory, its presence in Test No. 4, and its absence in the other three, are difficult to explain.

In contradiction of the old theory, however, Herr R. Ernst† has recently shown that the amount of this gas (CO) formed in the combustion of carbon depends upon the temperature of the fire; that, as the temperature of the fire is increased, a larger proportion of the carbon is converted into CO, until under very high rates of combustion, or, more specifically, when the temperature of the fire

is above 1,800 degrees Fahr., the first process of combustion is the entire conversion of the carbon into this gas. He has also shown that this gas will not burn, even in the presence of air, so long as its temperature is above 1,800 degrees Fahr.; it must be cooled before it will burn. Herr Ernst argues that, for high rates of combustion, there should be a rapid transfer of the heat liberated from the combustion chamber, in order that the carbon-monoxide formed may be sufficiently reduced in temperature to burn. This theory points to the possibility of heavy losses through the formation and non-combustion of carbon-monoxide in the locomotive firebox, in which very high rates of combustion are maintained, but the results of the Purdue experiments are reassuring: It must be admitted, however, that the relation of grate surface to firebox volume, during all but the first test, gave conditions which more nearly satisfy those prescribed by Herr Ernst than would exist had the same rates of combustion been maintained on a full grate. On the other hand, it may be urged that the rate of combustion maintained in Test No. 4 was higher than any which can be found in practice, a condition which would tend to neutralize the advantage of a large firebox. But, theory aside, the fact remains that the tests show very small losses by imperfect combustion, even when the rate of combustion is highest.*

CONCLUSIONS.

The results show that the most efficient furnace action accompanies the lowest rates of combustion; and while the precise relationships established by the experiments may not hold for fuel which is different from that employed, nevertheless they enforce the general conclusion that very high rates of combustion are not desirable, and, consequently, that the grate of a locomotive should be made so large that exceptionally high rates will not be necessary. They emphasize, also, the importance of spark losses, which, during the experiments under discussion, practically equalled in value all other losses occurring at the grate.

Leaving the conditions peculiar to the experiments, and assuming that the results obtained from them may be applied to the locomotive "Schenectady," when working under normal conditions, we find that the losses in evaporative efficiency which occur when the rate of combustion is increased above 50 pounds may be accounted for approximately as follows: The relation between the rate of combustion and the water evaporated per pound of coal, under nor-

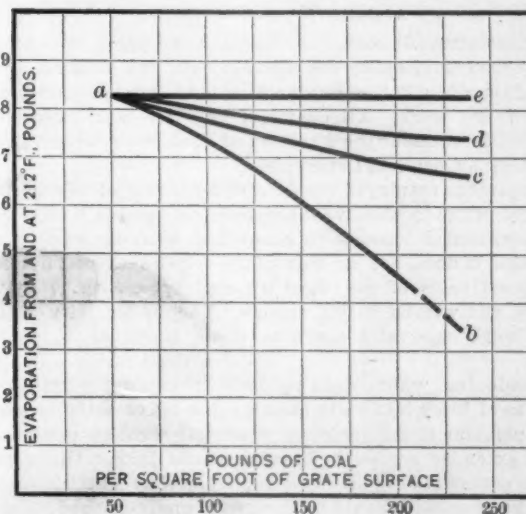


FIG. 2.

mal conditions, is represented by the line *a b*, Fig. 2. If it could be assumed that the heat developed in the furnace would be absorbed with the same degree of completeness for all rates of combustion, the evaporation would rise to the line *a c*; if in addition to this it could also be assumed that there were no spark losses, the evaporation would rise to the line *a d*; finally, if, in addition to these, it could be assumed that there were no losses by the excessive admission of air, or by incomplete combustion, then the evaporation would remain constant for all rates of combustion, and would be represented by the line *a e*.

That is, with the boiler under normal conditions, the area *a b c* represents the loss occasioned by deficient heating surface, the area

* The fact that the plan of the tests did not allow the boiler to develop the same power during all tests, may give rise to a question concerning the accuracy of this statement; it may be said that a portion of the effects produced is due to changes in power. Against such an objection, it may be urged that changes in power were comparatively slight, and it can be shown that their influence would diminish, rather than increase, the difference in the observed results. It is, therefore, safe to say that the losses at the grate are not less than those given.

† "The Principles of Combustion," a paper by R. Ernst, published as an inaugural dissertation at the University of Giessen, Hamburg, 1892. (See *The Engineer*, London, Aug. 4, 1893.)

* In a list of nine analyses of locomotive smokebox gases, selected by Mr. Kent from a large number made by Mr. P. H. Dudley, three exhibit CO. The amount varies from one per cent. to 2.5 per cent.

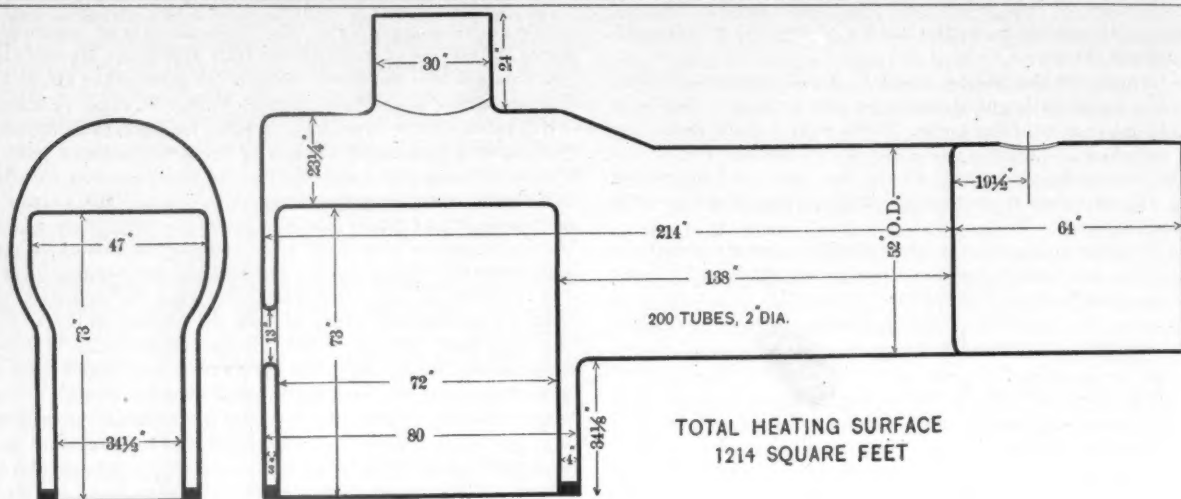


FIG. 3.

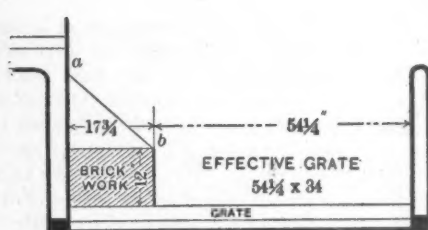


FIG. 4. TEST 2.

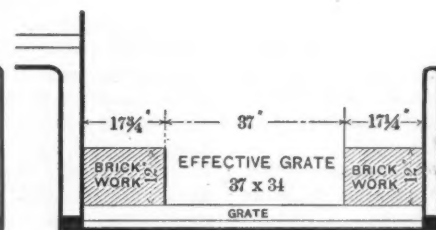


FIG. 5. TEST 3.

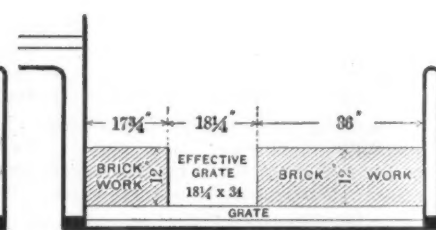


FIG. 6. TEST 4.

Boiler and Grates Used in Testing Efficiency of Different Rates of Combustion.

a c d that occasioned by spark losses, and the area *a d e* that occasioned by excessive amounts of air and by imperfect combustion.

APPENDIX I.

APPARATUS AND METHODS.

The experiments discussed in the foregoing paper were conducted by Mr. Alfred R. Kipp, in conjunction with Mr. Richard A. Smart, who, as Instructor in the Engineering Laboratory, had immediate charge of the work. All chemical analyses were made by Mr. Charles D. Test, under the direction of Prof. W. E. Stone, in charge of the Purdue Chemical Department.

The apparatus employed constitutes a portion of the permanent equipment of the locomotive laboratory of Purdue University, but this experimental locomotive plant has been so many times described that it does not in this place require special description. The locomotive is of the eight-wheeled type, with 17 by 24-inch cylinders, and weighs 85,000 pounds. The boiler, with which the present work especially concerns itself, is shown in outline by Fig. 3.

The deadening, which was employed to cut out portions of the grate, was of brick laid up in fire-clay, the effect being to make the covered portions of the grate as nearly air-tight as possible. The material extended across the breadth of the firebox, the sections of the grate covered being disconnected from the rocking mechanism, so that the remainder could be used with undiminished effect. Its distribution during the several tests is shown by Figs. 4, 5 and 6, respectively.

Early in the second test, ash piled up on the deadening, as indicated by the line *a b*, Fig. 4; but as the accumulation did not reach the lower tubes, it was not dislodged. At the end of the test, everything in the firebox which was not coal was credited to ash. During the third test there was less of this deposit, and during the fourth still less, an effect probably due to the presence of a stronger draft.

The thickness of fire for each test was not greater than was necessary to the easy maintenance of the steam pressure. The firing was always at regular intervals, and usually only three shovelfuls were thrown in at one time. In the fourth test the thickness of the fire equaled that of the deadening (Fig. 6).

The samples of smokebox gases for analyses were drawn from a point near the center of the smokebox. Ten minutes were occupied in obtaining the sample, a period sufficiently long to cover all conditions of fire.

The smokebox temperatures were obtained by means of a Le Chatelier pyrometer, an instrument constructed on the thermopile and galvanometer principle, and which, for comparative work, is very reliable. The differences in temperature recorded are probably correct within less than one per cent.

The weight of sparks or cinders passing the heating surface is the sum of those caught in the front end of the locomotive and those passing out at the top of the stack. The sparks which accumulated in the front end were easily collected and weighed. Of those which passed out of the stack, a portion only were collected, the sample being so chosen as to serve as a basis from which the value of the whole could be estimated. The apparatus employed in this latter process is shown by Fig. 7. It consists of an inverted U-tube of galvanized iron, securely fastened to a movable frame, by means of which the tip, which constitutes one extremity of the tube, can be projected across the top of the locomotive smokestack. The outer end of the tube may thus be made completely to intercept a portion of the stream issuing from the

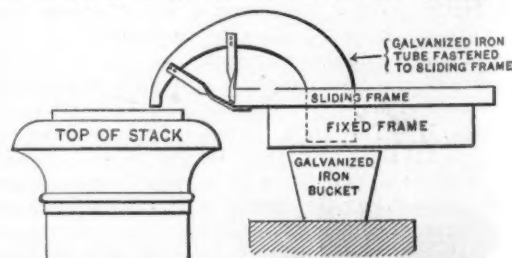


FIG. 7. SPARK TRAP.

stack, and the continuous action of this stream is sufficient to drive the intercepted portion through the tube and out at the other end. The gases passing the tube bear the sparks on their current, and they are collected in a bucket set to entrap them. Reference marks upon the sliding and the fixed frames permit the tubes to be placed in definite locations relative to the center of the stack. This device, when in service, catches everything excepting the lightest soot, which is allowed to escape unaccounted for.

After assuming the cross-section of the stream issuing from the stack to be cut up, by a series of concentric circles, into one circular and several annular areas, as shown by Fig. 8, the small end of the

U-tube was placed in the position marked *I* and held there for 30 minutes, the sparks collected during this interval being credited to this position. The tube was then moved to the position *II*, where it remained for another period of 30 minutes. In like manner, it was made to occupy, successively, the positions *III* and *IV*, and also the positions *I₁*, *II₁*, *III₁*, and *IV₁*, the weight of sparks caught during each interval being credited to the corresponding position occupied by the small end of the tube. This end of the tube had an area of one square inch, and it was assumed that the average weight of sparks passing the tube while in the positions *I* and *I₁*, would be the same as that passing every square inch in the annular space in which these positions are located. For example, the outer annular area, in which *I* and *I₁* are located, contains 88 square inches. If, in half an hour, 0.5 pound was collected by the tube in the position *I*, and in another half hour 0.3 pound was collected from the position *I₁*, the sum of these two weights, or 0.8 pound, collected during a period of one hour would be the average weight per square inch per hour collected from the two positions, and the weight for the whole outside annular area would be 0.8 times 88, the number of square inches, or 70.4 pounds per hour. A similar experiment and calculation gave the weight per hour delivered by each of the other annular areas *II* and *III*, and by the circular area *IV*. The sum of these separate determinations was assumed to be the total weight of sparks per hour delivered from the stack.

Other accessory apparatus employed was such as is commonly used in boiler testing, and therefore need not be described.

The engines of the locomotive were not involved in the tests, excepting as they served to shake the boiler, to furnish draft and to consume the steam generated. While the speed was varied slightly in different tests as a means by which desired rates of combustion might be the more readily secured, it was approximately 25 miles per hour for all tests. The running for each test, therefore, was equivalent to 150 miles.

In running the tests, regular observations were made at the beginning, and at five-minute intervals thereafter, giving 73 series of observations, upon the average of which the data are based. Exceptions to this rule are, however, to be made in the case of the spark record, to which reference has already been made, and in the case of the draft record, which was obtained by readings each minute during the first 20 minutes of every hour.

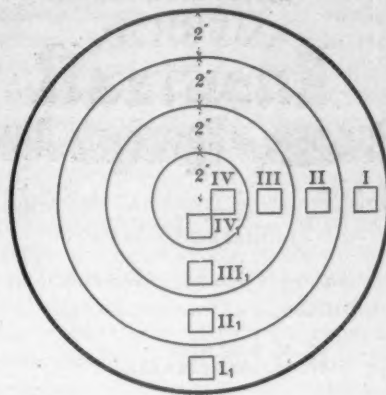


FIG. 8.

APPENDIX II.

OBSERVED AND CALCULATED DATA.

1. Test Number.....	Feb. 8.	Feb. 11.	Feb. 15.	Feb. 22.
2. Month and day (1896).....	6.	6.	6.	6.
3. Duration of test, hours.....	6.	6.	6.	6.
4. Approximate portion of whole grate used.....	Full.	Three-fourths.	Half.	One-fourth.
5. Exact area of effective grate, square feet.....	17.50	13.01	8.74	4.31
6. Barometric pressure, pounds.....	14.41	14.43	14.34	14.47
<i>Analysis of Coal.*</i>				
7. Per cent. fixed carbon.....	49.05	51.84	51.09	51.59
8. Per cent. volatile matter.....	40.29	39.00	38.93	38.87
9. Per cent. combined moisture.....	3.15	3.62	2.35	3.44
10. Per cent. ash.....	6.91	5.54	7.63	6.10
<i>Coal [Brazil Block].</i>				
11. Pound fired.....	6522.	6628.	6716.	6328.
12. Weight of water in each pound of coal fired.....	0.012	0.016	0.030	0.012
13. Pounds of dry coal for test.....	6443.	6522.	6514.	6227.
14. Pounds of dry coal per hour.....	1074.	1087.	1086.	1038.
15. Pounds of dry coal per hour per square foot of grate.....	61.4	83.5	124.2	240.8
16. Pounds of combustible for test.....	5792.	5921.	5856.	5635.
17. Percentage of fixed carbon in coal, dry and free from ash.....	56.	57.	57.	57.
18. Approximate number of B. T. U. per pound of combustible.....	13800.	14040.	14040.	14040.
19. Approximate number of B. T. U. per pound of dry coal.....	13000.	13000.	13000.	13000.
20. Theoretical evaporation from and at 212° per pound of dry coal.....	13.46	13.46	13.46	13.46
<i>Ash.</i>				
21. Pounds of dry ash in ash-pan for test.....	446.	396.	297.	164.
22. Pounds of ash in coal fired as shown by analysis of coal.....	445.	361.	497.	380.
23. Pounds of ash by analysis, minus pounds found in ash-pan.....	-1.	-35.	200.	216.
<i>Analysis of Sparks.*</i>				
24. Per cent. of fixed carbon.....	61.74	64.88	71.32	76.44
25. Per cent. volatile matter.....	4.36	4.16	3.45	3.29
26. Per cent. combined moisture.....	1.82	1.82	1.66	1.86
27. Per cent. ash.....	32.08	29.14	23.57	18.41
<i>Sparks.</i>				
28. Pounds caught in front-end during test.....	75.	213.	494.	566.
29. Pounds passing out of stack for test.....	294.	358.	278.	492.

* All chemical analyses were made under the direction of Professor W. E. Stone, by Charles D. Test, A. C.

Test Number.....	1	2	3	4
30. Total pounds of sparks for test.....	369.	571.	772.	1053.
31. Pounds of sparks per square foot of grate per hour.....	3.5	7.3	14.7	41.0
32. Pounds of combustible in sparks for test.....	242.	395.	576.	837.
33. Percentage of fixed carbon in sparks dry and free from ash.....	94.	94.	95.	96.
34. Approximate B. T. U. per pound of sparks.....	9870.	10360.	11200.	11880.
35. Pounds of coal equivalent in heating value to one pound of sparks.....	0.75	0.80	0.86	0.91
36. Pounds of coal equivalent in heating value to total weight of sparks for test.....	277.	457.	664.	963.
<i>Analysis of "Smoke-Box Gases."</i>				
37. Per cent. carbon dioxide.....	5.25	6.25	4.80	1.80
38. Per cent. heavy hydro-carbons.....	0.50	0.40	0.40	0.50
39. Per cent. oxygen.....	12.15	11.80	14.60	13.70
40. Per cent. carbon monoxide.....	0.00	0.00	0.00	0.55
41. Per cent. nitrogen.....	81.90	81.55	80.20	78.45
<i>Other Smoke-Box Data.</i>				
42. Diameter of Double Exhaust tip.....	3.	2.75	2.35	1.75
43. Draft in inches of water.....	2.2	2.5	3.3	5.6
44. Temperature of smoke-box, degrees F.....	647.	629.	610.	500.
<i>Water and Steam.</i>				
45. Pounds of water delivered to boiler.....	44756.	43081.	40710.	43770.
46. Temperature of feed, degrees F.....	54.0	53.0	53.5	52.7
47. Boiler pressure, by gage.....	129.4	127.2	127.2	129.1
48. Quality of steam in dome.....	0.982	0.981	0.984	0.983
<i>Evaporation.</i>				
49. Pounds of water evaporated per pound of dry coal.....	6.94	6.60	6.30	5.58
50. Equivalent evaporation from and at 212° F.....	8.26	7.87	7.52	6.67
<i>Horse Power.</i>				
51. Horse power of Boiler.....	257.	248.	226.	201.
52. Horse power per square foot of grate.....	15.	19.	26.	47.
<i>Approximate Efficiency.†</i>				
53. Ratio of heat developed in the furnace to heat absorbed by water.....	0.61	0.59	0.56	0.50

* All chemical analyses were made under the direction of Professor W. E. Stone, Charles D. Test, A. C.

† The efficiency is approximate only, since the heating value of the coal is only approximately known. Since the same coal was used for all tests, there can be no error in using this factor for purposes of comparison within the limits of the present series of tests.

Our esteemed contemporary, the *Iron Age*, has removed its offices from 96-102 Reade street to 232-238 William street, New York.

The offices of the Colliery Engineer Company, proprietors of *The Colliery Engineer and Metal Miner*, *Home Study*, and the International Correspondence Schools, in the Coal Exchange Building, Scranton, Pa., were partially destroyed by fire on Sunday morning, Aug. 30, 1896. Fortunately the printing plant was in another building, and the reserves of all instruction and question papers, drawing plates and other supplies and stationery used in the schools in still another building, so that its business will not be seriously interfered with.

(Established 1832.)

AMERICAN ENGINEER

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27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

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NOTICE.

To manufacturers and business men who want to prepare at once for the improvement in business that will result from the defeat of free silver on Nov. 3d, and who yet hesitate to incur any new obligations at present, we make the following proposition:

To those who make advertising contracts with us before Nov. 3d we will agree to publish their advertisements for one year on the condition that if Mr. McKinley is elected President they will pay for them at the regular prices, but if Mr. Bryan is elected, their advertisements in this journal will be free of charge for the period covered by their contracts.

We have enough faith in the result of the campaign of education now going on, in which the railroad technical press is taking such a creditable part, to make this offer to those who still hesitate to resume business activities.

BUSINESS, HONESTY AND PATRIOTISM.

If the present unsatisfactory condition of business were the temporary result of political agitation and of politics only, we would not feel that it was the province of this journal to take sides or express any opinion on the issues involved. But the present crisis in our national and individual affairs has been brought about not by politics but by an avowed determination of persons ignorant of the natural laws of finance and commerce to overthrow our present coinage system and (if they get the chance) launch this country upon a dangerous sea of financial experiment and theory which can only end in disaster and ruin. The mere announcement of such a programme has applied the brakes to all enterprise and trade expansion, and brought to a standstill everything that could stop. The result would have been the same if any other party of sufficient power had advocated free coinage of silver, for in commercial and financial affairs, just as truly as in railroading, a danger signal is an order to stop, irrespective of who set the signal.

Most of our readers are employed by, or are interested in, railroads and industrial and manufacturing enterprises. If the proposed free-silver legislation is ever carried into effect their interests will be hit promptly and hit hard, and that, too, without any definite gain to the country at large, but with certain disaster. We do not need to tell our readers that their interests are already affected. Railroad reports for the year ending June 30, 1896, taken as a whole, show that railroads had recovered from the depression of the two or three years immediately preceding, and were enjoying a business that had seldom, if ever, been exceeded in their history. Their purchases of material were heavy, and concerns supplying it were prosperous. The great volume of the transportation business indicated returning prosperity in all directions.

The first of the political conventions gave an added impetus to business because it declared for a gold standard. One of the largest builders of machine tools told us last week that the orders his firm received during the month of that convention were the largest in its history. Then followed the other conventions, with their platforms threatening the stability of our currency, and even of the government itself. The danger signals were set and things stopped moving. They stopped so quickly that, to quote again the experience of the concern above mentioned, it received that month just one-fifth as many orders as in the preceding month, and now it has none.

Our readers are practical men who in technical affairs refuse to base their actions on theories not supported by facts. In the present campaign against sound money, many glowing promises are given and attractive theories promulgated that are not supported by facts. We don't for a moment believe that they will be entertained.

It is claimed that under the free coinage of silver at a ratio of 16 to 1, silver will rise in bullion value to \$1.29 per ounce, and that our gold and silver currency will circulate at equal value as now. If such an absurdity could be brought to pass what would be accomplished? Simply that the silver-mine owners of the world who are now selling 175,000,000 ounces of silver annually for

about \$114,000,000 and realizing a handsome profit thereby, would receive for this bullion \$225,750,000, or an additional profit of \$111,750,000; furthermore, as if that were not enough for these favored persons, the taxpayers in these United States will generously pay the expense of coining as much of this bullion as the owners of it desire to have coined. After coining it, the money will be placed in the hands of the bullion owners and they will say how and when it goes into circulation. Does any one for a moment suppose that those millions of additional profit would ever reach the pockets of the great body of our citizens working for salaries and wages on any more favorable terms than the present dollars do? If not, why should we vote these enormous profits into the pockets of any one class of citizens or of foreigners?

But as the price of silver will not rise to the value of \$1.29 per ounce—for the pages of history bristle with facts that say it will not—then the proposed legislation is positively dishonest. For us, either as a nation or as individuals, to borrow 100-cent dollars and to deliberately pay back our obligations in dollars worth only 50 cents, is so rankly dishonest that we do not believe the citizens of this nation, whose proud record is that it has always stood for fair dealings among the nations of the earth, will ever permit such methods to come to pass.

We have too much faith in the intelligence of our citizens to believe that the result in November will be anything else than a free-silver funeral. And after burying this fallacy so deep that it will never rise again, we can then look forward to years of prosperity for all.

The use of a leading four-wheeled truck under express locomotives is gaining favor in England and on the continent, some believing it the safer construction, while others, not admitting the need of it, use it for the reason that they find the engineers make better time because of their confidence in it. The report on the accident which occurred last May on the North British Railway also contains an argument in favor of the leading four-wheeled truck. The accident was caused by the expansion and consequent lateral deflection of the rails by the excessive heat of the sun at that time. Lieutenant-Colonel Yorke, reporting to the Board of Trade, says: "The fact that the engine did not leave the rails, although the rest of the train did, may probably be attributed to the flexibility imparted to the engine by the leading bogie, which was able to adjust itself to the irregular curvature of the lines produced by the expansion of the rails, whereas the tender, with its six wheels and rigid wheelbase, was most probably the first vehicle to leave the metals and dragged the rest of the train after it."

The new cruiser *Brooklyn*, built for the United States government by the Cramps, and illustrated elsewhere in this issue, has undergone her official trial trip and developed a speed of 21.9117 knots per hour. This was the average speed over the entire course of more than 80 miles, and the maximum speed between two buoys was 22.90 knots. This remarkable performance is a source of gratification to both the builders and the government. It speaks well for the ability of the builders and the designers, and it is calculated to awaken feelings of justifiable pride in the hearts of patriotic citizens. Such excellent records also have a money value, not alone to the builders, who in this case earned \$350,000 in premiums, but to the country that foots the bills. The progress of naval construction is so rapid nowadays that vessels which do not come up to the highest standards of speeds and fighting power for their respective classes will soon become obsolete and be no match for later additions to other navies. The production, therefore, of vessel after vessel of speeds approximating that of the *Brooklyn*, or of fighting power and resistance to projectiles like that possessed by the *Indiana* and *Oregon*, puts the United States in possession of men-of-war that to-day excel similar vessels in the other navies of the world, and that are sure to be up to date for many years to come. Thus the tax-paying citizen is assured that for every dollar put into these vessels the best possible return is received.

From the part of a discussion before the London session of the

International Railway Congress published on another page, one can see that much ignorance exists in Europe in regard to many details of American railroad practice. From the discussion on slide valves for express locomotives it would appear that European engineers are exceedingly anxious to use balanced valves, and are only deterred from so doing because of the absence of a satisfactory method of construction. And yet the universal practice in this country is to employ balanced valves on such engines, and they are almost all of the Richardson type. Practice here has become so uniform that it is conclusive evidence of the satisfaction given by this kind of balanced valve in regular service. Before European engineers get discouraged in their search after a good balanced valve, they had better investigate American practice. There is so much incredulity in the minds of these gentlemen regarding the statements of American doings, fostered probably by the spread-eagle style of our daily press, that it may explain their neglect to investigate our practice. This incredulity is well illustrated by what Mr. H. S. Haines said in his recent address to the American Railway Association. He stated that "when the American delegates spoke at the London Congress of handling 50 or 100 trains a day, and 30,000 or 40,000 cars a month over a single track, the statements were evidently received as specimens of American brag."

The tests of a 300 horse-power De Laval steam turbine to be found on another page are of considerable interest, not only from the low steam consumption at full load of 17.348 pounds per brake horse-power, and 19.275 pounds per electrical horse-power, but also from the fact that at 89 per cent. of full load the performance was equally good, while at 56 per cent. the water consumption was only 20.22 pounds per electrical horse-power, and at 18½ per cent. of full load it had only risen to 27.35 pounds per electrical horse power. This excellent performance and the small space occupied by the turbine are greatly in its favor, and while the first cost may now be as great per horse-power as for a reciprocating steam engine, there would seem to be a reasonable prospect for a great reduction in the price of the turbine. Against these advantages, actual and prospective, must be placed the high speed of rotation, necessitating gearing that may prove expensive to maintain. The large turbines whose tests are recorded in the article already alluded to, should, in the course of a few years, furnish some valuable experience on this point. Should the gearing for large powers prove subject to break down and expensive to maintain, the turbine may be limited in its usefulness to small powers or to the driving of machinery running at such speeds as not to require the gears at all. It is of interest to note that in the case of dynamos, it may be possible to do this in the not distant future, for at least one large firm manufacturing dynamos and motors is at work upon a motor that will run at a speed of 10,000 revolutions per minute. This motor, if it can be successfully constructed, will be used by the United States government on men-of-war to start the propelling machinery of Howell torpedoes just before they are fired from their tubes. This torpedo is propelled by the energy stored in a small fly-wheel inside of it, made to revolve at a speed of 10,000 revolutions, and at present a steam turbine is the only motor of simple form that is available to rotate the fly-wheel at that speed. But there are serious objections to steam pipes leading to the vicinity of every torpedo tube on the vessel, and hence there is an earnest call for a high-speed motor. If this demand is met it may show the way to the construction of high-speed dynamos capable of being driven directly by turbines.

THE USE OF BUFFER BLOCKS WITH VERTICAL PLANE COUPLERS.

When the railroads of this country began the use of vertical plane couplers in freight service, many cars were equipped with buffer blocks for the better protection of the draft gear and the link and pin couplers then in use. With the introduction of the new couplers the use of these buffer blocks was in a number of cases abandoned and the more expensive couplers allowed to take all the shocks of service without protection. Many railroad officials have thought this policy a mistaken one, but there was one

good defense for it in the fact that the face of the vertical plane coupler is three inches further from the face of the dead wood than the face of the link and pin bar, so that when couplers of the two types were brought together the buffer blocks were non-effective. If two vertical plane couplers were coupled together the blocks would be as effective as when two link and pin couplers were united, but as in the early days of the introduction of the M. C. B. couplers their number was small compared with the old type, it is evident that such buffer blocks as were placed on cars so equipped would seldom be effective in relieving the draw gears of buffing strains. Consequently there was reason in the argument that they could be omitted until such time as the M. C. B. couplers became numerous enough to warrant their use.

It is believed by many that time has now come, but unfortunately, in the period when the number of roads using buffer blocks diminished, many persons appear to have lost sight of the fact that under the right conditions the blocks would afford a much-needed protection to the couplers; hence it is not easy to arouse an interest in them now. Those who are using them are, however, fully convinced as to the wisdom of the expenditure, for they find the resulting saving in the repairs to draft gears to be remarkable. On a road in the East handling at one point several thousand of its own cars every one of which is equipped with the buffers, and about as many hundred cars of a connecting line not equipped with the buffers, the aggregate repairs to the draft gears is more on the foreign than on the home cars, notwithstanding that the latter are nearly ten times as numerous. The cars are all in the same coal traffic, are quite similar in construction, and there does not seem to be any reason for the difference in the cost of repairs except the absence of buffers in the one case.

It does not seem unreasonable to conclude that when all cars are equipped with M. C. B. couplers, the use of buffer blocks would permit a lighter construction of the coupler so that part of the metal now put in the coupler to meet buffing strains, will be transferred to the buffer blocks, where it can better perform its proper function of protecting the draft rigging. If this is the case, the actual cost of the buffers will not be as great as might appear. Certain it is that the method of taking the buffing shocks upon the bracket of the coupler, over an area so small as to rapidly break down the fibers of the end sill and to bend any plate or angle iron used to protect the sill, and at an average distance of at least 4½ inches above the center of the stem, by which leverage fractures through the stem back of the head are deliberately invited, is wrong in principle, and it is believed that it will ultimately be changed.

The advantages arising from the use of buffer-blocks seems to be so clear that discussion is almost unnecessary. The facts are all in favor of those who use them. But it may not be out of place to call attention to the necessity of preserving the standard distance of 10½ inches from the face of the deadwood or sill to the inner face of the hook, or 8½ inches from the horn of the coupler to the hook. That these figures have not been adhered to is evident from investigations made by several parties. We have before us the results of two sets of measurements made on a large number of different makes of couplers, one set being taken in the West and another in the East. Altogether 35 different kinds of M. C. B. couplers were measured. In some cases the two measurements of one kind of coupler agreed, in others they did not, but giving the manufacturer the benefit of the measurement nearer to the standard, the result may be stated as follows:

1 coupler measured 8 inches from knuckle to bracket.					
1	"	"	8¼	"	"
1	"	"	8½	"	"
2	"	"	8½	"	"
17	"	"	8¾	"	"
1	"	"	8¾	"	"
8	"	"	9	"	"
2	"	"	9¼	"	"
1	"	"	9¼	"	"
1	"	"	9¾	"	"

It might be inferred that the 17 couplers which conformed to the standard included all the couplers extensively used, but such is not the case. Many of the well-known couplers conform to standard, but among the couplers that are over size are a number

of well-known bars. The importance of making all couplers conform to the standard in this respect is so evident that surely the lack of conformity need only be pointed out to be remedied. The couplers that measure from 9 to 9¼ inches between the points mentioned will not permit the buffers to become operative until the sill or draft-rigging have been driven in sufficiently to damage and weaken them materially. Hence with such couplers those who apply buffers fail to get the benefit of them, and those who do not employ them would have the same trouble if at any time within the life of those couplers they should change their practice and apply the buffers. Manufacturers may have already altered their patterns to conform to the standard, but regular inspection on this point is desirable.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

II.

The admirable paper by Professor Goss, which was read and discussed at the meeting of the New York Railroad Club, on Sept. 17, and which is reprinted on another page, gives fresh interest to the above subject, the discussion of which was commenced last month. At the meeting referred to the observations took a somewhat wide range, and were not confined alone to the points brought out in the paper, and in reality embraced a good deal of what is implied by the above title. It has always been known that very high rates of combustion are not only not economical, but are very wasteful, but Professor Goss' investigation have established this fact on what seems to be complete scientific proof. But another fact was also brought out in the discussion, which was that in burning bituminous coal if very large grates—such as are used in the Woolten firebox—are employed, that greater economy resulted by covering part of the grate with fire-brick or dead-plates than was attainable with the whole grate open. The demonstration of this fact however, is not as complete, as that presented by Professor Goss. The inference, however, is that while a grate may be too small—and probably most of these now in use are not large enough for economy—yet it is possible to have too much grate surface as well as too little. An average consumption of fuel of 100 pounds per square foot of grate per hour is not unusual—for light trains it is much less. The minimum consumption, probably, is often below ten pounds per square foot per hour. Supposing that the size of the grate was doubled, then the minimum might be less than 5 pounds. The lowest rate of combustion tested by Professor Goss was 61 pounds. It is to be regretted that he did not try the results on evaporation with much lower rates. With the present construction of grates, the question is, what size will give the best average results. A grate of a certain size might be wasteful with very high rates of combustion, but be economical when the engine was not working very hard. On most roads it is only during very short periods of time that locomotives must exert their maximum power. During much the greatest part of the time they are at work the consumption of coal is only at very moderate rates. As the conditions of working are constantly varying, it would seem to be desirable to have a grate whose size could be increased when the engine is working hard, and diminished when the demands are not so great.

Reference has been made in these columns heretofore to an engine of the Columbia type, which Mr. Rhodes, of the Chicago, Burlington & Quincy Railroad, had built, as a sort of experimental engine, to test that form of locomotive, and which was illustrated in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for last December. As shown from the illustrations and description of that engine, which were then published, its two driving axles and wheels are in front of the firebox. The latter could, therefore, be made as wide as might be desired, and as deep as the trailing wheels below it would permit. In reality its inside dimensions were 8 feet 10½ inches long by 5 feet wide. This engine, we learned some time ago, was showing a very marked economy over other engines of similar capacity on the road on which it is running, as we ventured to predict it would.

At the time it was illustrated we called attention to the theory

advanced by Mr. Siemens that combustion is arrested when flame comes in contact with any solid substance, as is illustrated by inserting a wire into an ordinary gas flame. His inference was that it is desirable in all furnaces to keep the flame out of contact with the sides, ends and top of the firebox as long as possible, or until the process of combustion is completed. From this the deduction was drawn that the ideal form for a firebox would be a sphere or a cube—or, in other words, that its length, breadth and height should at least be approximately equal. A very common area of grates of locomotives is from 20 to 25 square feet. In Mr. Rhodes' engine he has nearly 45. Our prediction was based upon Mr. Siemens' theory, and also on our somewhat vague belief in what Professor Goss has since proved by his experiments. The deduction—which has since been confirmed by actual experience—was made from purely scientific data. It was an evolution of science and not of practice, and illustrates the value of science to railroad companies.

At the meeting of the Railroad Club, which has been referred to, a letter was read which was written by Professor Ostwald, a distinguished German chemist, to a fellow professor in England, in which he describes the means adopted in Germany which has enabled manufacturers in that country to compete successfully with Englishmen. Referring to his own specialty, Professor Ostwald said:

"Each large work has the greater part of its scientific staff—and there are often more than 100 Ph. D.'s in a single manufactory—occupied, not in the management of the manufacture, but in making inventions. The research laboratory in such work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability, they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years."

Commenting on this, the *New York Evening Post* says:

"Is it any wonder that by such methods Germany has come to control the fine chemical markets of the world? By her superiority in this respect alone she is able silently and without any legislation to lay a tax upon almost every industry in every country. German manufacturers have come to a clear understanding of the commercial importance of science. Not long ago one of them offered a university professor a very large salary simply to come into his works and make experiments regarding the practical use of certain scientific methods which the professor had been developing. This close relationship between science and industry is good for both. It puts the best trained and highest inventive power at the service of manufactures, and it also furnishes the scientist not only with new openings for a livelihood, but with wide opportunities for research."

Might it not be wise for some of our railroad companies to follow the example of the German chemists?

In an article published in the *AMERICAN ENGINEER* of December, 1894, it was shown that in the best performance of locomotives the fuel consumption is only half that of the average performance on well-managed roads. A very considerable economy would therefore seem to be possible if railroad companies would take some such steps as the Germans have taken to avail themselves of the greatest economies possible. Referring to the letter quoted the *New York Post* says further:

"Its significance was at once preceived. Here was something deeper and more powerful than tariffs. Here was a frank disclosing of the hiding of German power as a competitor for the world's commerce, with the unavoidable inference that there was but one way to rival it—not by laws or diplomatic manoeuvres, but by meeting knowledge with knowledge and skill with skill."

There is probably no general subject which is now receiving so much attention from railroad managers as that of economy of operation. In many cases this has been a matter of life or death, or "to be or not to be"—in the hands of a Receiver.

To show how this subject appears to a person who regards the subject from the monetary side alone, the following quotation from the financial article of the *New York Times* of Sept. 20 is reprinted. The writer of the article says:

"That the St. Paul railroad managers have but recently discovered how to work their road more cheaply than any other granger road, and far more cheaply than the Lake Shore road, or the Pennsylvania system, not to speak of other large systems; and that this knowledge has been progressively acquired and applied, will appear from the following brief table:

Year.	Ratio.	Gross Earnings.
1893	65.19	\$33,000,000
1894	64.21	31,300,000
1895	62.35	27,300,000
1896	60.21	32,000,000

"Now, if the St. Paul managers had not acquired this knowledge, and had worked their road in the last fiscal year at 65 per cent., the surplus for the common stock would have been just 4.40 per cent., with 4 per cent. paid as dividends. As they were able to do it for a little over 60, they showed 8 per cent. earned. Thus it appears how advantageous it would be if other corporations had St. Paul managers."

We have not undertaken to analyze these figures, or the cost of operating the lines whose expenses are unfavorably compared with those of the St. Paul road, knowing, as we do, how misleading such a basis of comparison may be. Thus at 60.21 per cent. of gross earnings of \$32,000,000 reported for the St. Paul road for 1896, the expenses would have been \$19,267,200. Now suppose the rates for carrying freight and passengers during that period had been increased 10 per cent., the expenses remaining the same, their percentage would then have been only 54.4 per cent. of the earnings. On the other hand, if the rates had been reduced 10 per cent., the expenses remaining the same, then the latter would have been 66.9 per cent. of the earnings. Doubtless under the former state of affairs the wise men who write financial articles for the papers would have commended the managers and in the latter condemned them, while, as a matter of fact, the management would have been just as good in the one case as in the other, and in fact the economy would have been exactly the same in both. The difference of cost in running a passenger train is almost or quite inappreciable whether the trains are filled or not. Cost of superintendence, office expenses, salaries, interest, etc., remain very nearly the same whether the volume of traffic is large or small, but the relation or the percentage of the expenses to the earnings will diminish as the latter increase and vice versa.

For these reasons not much importance is assigned to what may be called the quantitative comparison of expenses of earnings, but it is true of railroads, as Thackeray jocularly expressed it of personal receipts and disbursements—income £2 9d.; outgo £2 10d.; result—misery; income £2 10d.; outgo £2 9d.; result—happiness. Of railroad companies it might be said—income \$3,000,000; expenses \$2,900,000; result—a dividend; income \$3,000,000; expenses \$3,000,000; result—a Receiver.

In the article in the *New York Times* which has been quoted it was said that the late Mr. Newell, President of the Lake Shore Railroad, had spent his life in improving that line, by straightening its curves, reducing its grades, improving its terminal facilities so as to make it more efficient as a dividend-earning enterprise. Mr. Newell was by profession and training a civil engineer and had an intimate knowledge of all the requirements which are essential in a great line of road to carry freight and passengers economically. He used this knowledge to the best advantage, but Mr. Newell was not a mechanical engineer and could not see as far through the furnace door of a locomotive as he could through an engineer's transit. All the indications seem to show that a mechanical engineer with the breadth of mind, knowledge, ability and level-headedness that Mr. Newell had could accomplish as much in the improvement of the efficiency of the rolling stock of a great railroad as he did in perfecting the line of the great road of which he was President.

This subject is again too big for the space we can now give to it, and so must be taken up again.

We heartily indorse the work which the *Railway Age* and other technical papers are carrying on for sound money in the present disturbed condition of business. It is worthy of the approbation of all who are interested in the cause of good government for all the people and opposed to measures that could only benefit the few at the expense of disaster and ruin to the many.

NOTES.

Mr. Shadrach A. Mustain, of Rincon, N. Mex., has patented a globular car. It consists of two globes for "transporting matter" attached to a suitable frame and having axles running in journal boxes. Each globe has two cylindrical surfaces, which form treads that run on the rails. The globes are hollow and the lading is carried inside of them. These would make excellent "rattlers" for cleaning castings, scrap iron, etc.

A test of the relative cost of coal and coke fuel was recently conducted for the directors of the gas and water works of Colmar, Germany. The tests were conducted on the boilers of the pumping plant of the town. The caloric values of the coke and coal were in the ratio of 1 to 0.89. The results showed that the cost of coke fuel was .92 times that of the coal required to generate the same amount of steam, or a saving of about eight per cent. in favor of the coke. The cost of the coal and coke per ton is not stated.

In the annual report of the New York, New Haven & Hartford Railroad for the year ending June 30, 1896, a reference is made to the company's experiment with the use of electricity as a motive power, and the statement is made that the result has been most gratifying and that it is now probable that a third rail may be laid at several points on the company's lines, after which short lines to centers of business and population would naturally follow. The company paid four dividends of 2 per cent. each last year, amounting to \$3,608,542.

The use of a pneumatic arrangement for whitewashing and painting is gradually spreading. It has reached England and is received with favor there. It is in this country used on several large systems to paint freight cars, sheds and buildings along the line. Painting of ships is another of the operations in which it ought to work well, and it has, we believe, been already employed in this manner. The arguments at first raised against the process, the chief one of which was that the paint would not stick, seem to have been swept aside.

Mr. L. L. Buck, Chief Engineer of the new East River bridge estimates that with no unexpected delays and with the needed money forthcoming, the bridge can be completed by Jan. 1, 1900, at an expenditure of \$7,510,000 on new contracts. Of this sum \$1,360,000 is required for tower foundations, \$1,640,000 for anchorages, \$372,000 for the steel towers and \$248,000 for their erection, \$750,000 for the cables and their erection, \$1,610,000 for the suspended superstructure and its erection, \$1,300,000 on approaches, and \$230,000 on flooring, painting, etc.

In a paper read before the Institute of Naval Architects, Col. N. Soliani, Director of Naval Construction in the Royal Italian Navy, recommended the adoption of compound marine boilers; that is, he proposes "compounding cylindrical boilers with water-tubes in such a way as to make them partake, to a certain extent, of the good features of the water-tube boilers, without detracting much from their own valuable characteristics." "Such a result," he says, may, in his opinion, "be achieved simply by doing away altogether with the water-spaces around the ordinary combustion chambers and substituting for them water-tubes, some of which could be properly arranged as a protecting screen in front of the tubes and tube-plates."

Three robbers tried to hold up the overland train on the Southern Pacific one night last month at a point between San Francisco and Sacramento. The engineer and fireman were covered by revolvers in the hands of two men, who crawled over the tender. The train was stopped by their orders and one of the would-be robbers left the cab to join an accomplice and aid in cutting out the express car, taking the fireman with him. The third robber guarded Engineer E. F. Ingles, but his attention was fixed on something else for a moment and the engineer promptly availed himself of his opportunity and shot him dead. The other two escaped. The fireman managed to elude them and got into the first coach as the train started again.

In a paper recently read before the Société Technique by Mr. Ravel, the author stated that acetylene kindles at about 900 degrees Fahr., while other inflammable gases fire at about 1,100 degrees Fahr. He said the temperature produced by the explosion of acetylene is over 7,200 degrees Fahr., while that of the oxy-hydrogen blowpipe is not more than about 5,400 degrees Fahr. This high temperature, together with the small amount of water vapor produced, makes the explosion of acetylene a very violent one. The flash produced is a blinding one, and it is very dangerous to bring a flame near a leakage of acetylene. Then the ease of lighting and the force of explosion promised to render acetylene very useful in gas engines. Tests were therefore made. The engine at first made a series of loud, sharp explosions, which threw the indicator lever out of gear. The lubrication had to be doubled, and the degree of cooling had a great deal more influence on the efficiency than when coal gas was used. The indicated work falls off with the proportion of acetylene. As the acetylene is increased the initial pressure rises, but the fall of pressure is immediate and the expansion is not kept up. As the acetylene approaches five per cent., the explosions become destructive, and there seems to be internal vibrations in the mixtures in the cylinder. Diminishing the compression, these vibrations are less and the work done is greater. The work done is then about 2.1 times as great as can be obtained from an equal volume of coal gas. Acetylene cannot be advantageously used in motors as at present constructed, for either it has to be too much diluted or else the explosion is too sharp.—*The Practical Engineer.*

An exchange says that at a recent congress of German engineers, at Cologne, Mr. Mausel presented a paper showing by that the use of petroleum water can be pumped in places where steam or hydraulic motors cannot be employed and gasworks do not exist. Gas motors are also adapted to the working methods of a gas plant, as the power can be utilized during the day time, when there is little or no demand for the gas as an illuminant. Germany was the first country to adopt gas as a motive power in pumping water. Gas motors, for this purpose, were installed at Duereu and Quedlinburg in 1884, at Coblenz and Rothweil in 1886, at Fuerth and Peine in 1887, and at Münster and Carlsruhe in 1888. In some of these plants the gas motors are used with steam engines to supply any emergency demand. The last two plants in the following table show a material improvement in the utilization of gas. The motors used at Münster have an efficiency of 912,950 foot pounds per pound of fuel used. As an average there was used at this plant, in 10 hours, 170 pounds of coke and 400 pounds of anthracite coal for producing gas. A steam engine would have consumed three times this amount of fuel for the same work. At Rothenburg, where the motors are run with gasoline, the efficiency is 1,603,750 foot pounds per pound of gasoline. At Hohenstein, petroleum motors give an efficiency of 1,724,000 foot pounds per pound of petroleum. The following table shows the results obtained by gas motors in different waterworks, these works being arranged according to date of erection:

Towns.	Number of motors.	Horse power.	Foot-pound produced per cubic foot of gas used.
Duereu.....	2	40	46,565
Quedlinburg.....	2	15	49,258
Coblenz.....	3	40	54,071
Fuerth.....	2	40	54,071
Carlsruhe.....	2	50	53,047
Kettwig.....	1	15	47,313
Einbeck.....	2	10	48,234
Bingen.....	2	12	52,228
Goettingen.....	1	10	52,676
Meissen.....	2	50	70,460
Constanz.....	1	10	71,276

Superheating has for its sole purpose and result in the steam engine to-day the extinction or reduction of the internal thermal wastes of the engine, consequent upon the phenomenon known as initial or "cylinder condensation." Here it is extraordinarily effective, and a small quantity of heat expended in superheating the entering steam effects a comparatively large reduction in the expenditure of steam in the engine, each thermal unit thus employed saving several thermal units otherwise wasted. The process is one, mainly at least, of prevention rather than of cure of

that fault, and prevention is, as usual here, found to be vastly more effective than attempted cure.

Superheating is superior to any other known means of reduction of internal waste. Jacketing ordinarily suppresses but a fraction of that waste, and the multiple-cylinder engine has also its limitations, while superheating may not only extinguish it, but may also check wastes due to the resistance to flow of the denser wet steam through steam and exhaust ports, and may sensibly improve the vacuum attainable in the condenser, with corresponding reduction of back pressure, of the quantity of condensing water demanded, and of the load on the air pump. Superheating even a few degrees improves considerably the performance of the engine, and in the average case superheating 100 degrees Fahr. will entirely extinguish that waste. The hitherto unconquered obstructions to the use of superheated steam in the engine have been those resulting from destruction of packing and decomposition of lubricants, with consequent friction and "cutting" of the rubbing surfaces. The introduction of metallic packings and the high-test lubricants has now enormously reduced the difficulties of application of superheating. No trouble need now be found at the engine with sufficient superheating, under usual conditions of operation, to annihilate cylinder condensation. It seems not at all improbable that even this limit may be ere long safely, and perhaps even largely, overpassed, with resulting improvement of thermodynamic efficiency.—*Dr. R. H. Thurston, before the Am. Soc. of Mech. Eng.*

In a paper before the American Society of Mechanical Engineers, describing a new steam calorimeter in which the water is separated from the steam by a sudden change in direction of flow which causes the water by its inertia to be forced through the meshes of a cup placed in its pathway, the water being collected and measured, while the weight of the dry steam is derived by its flow through an opening that has been calibrated, for different pressures. Prof. R. C. Carpenter gives the following conclusions as guides to calorimetry practice: First, the steam ordinarily discharged from a boiler of proper proportion and in good working condition carries an exceedingly small percentage of water. Second, a certain amount of water will be carried along by the steam in the form of vapor or small drops; that this amount varies somewhat with the velocity, but probably does not exceed two or three per cent. by weight, and furthermore, a fair sample of such steam is usually obtained by any of the ordinary methods in use. Third, water is sometimes thrown from the boiler in large amounts, and in such a case it will usually remain distinct from the steam and will pass along the bottom of horizontal pipes in a stream of greater or less depth, and will flow if moving downward in a vertical pipe in irregular positions depending upon its velocity and various other considerations. Steam carrying water in this way when ascending in a vertical pipe will probably be irregularly charged, and samples drawn from time to time are likely to vary greatly. This condition can usually be considered an abnormal one and probably cannot be fairly sampled by any method. In case large amounts of water are thrown over, the quality of the steam cannot be even approximately obtained without the use of a steam separator for removing the excess of water. Fourth, steam, even in a very dry condition is likely to deposit a film of water on the inside of the pipe by condensation. This amount is rarely of sufficient importance to greatly affect the results, but if the calorimeter is so located as to draw this directly into the pipe it may show very wet steam when the contrary condition actually exists. The writer believes that samples for calorimetric determination should be drawn from a vertical pipe in which there is an ascending current of steam, and that the sample should be taken as uniformly as possible from all sections of the pipe, except that no steam should be drawn immediately adjacent the exterior portion of the pipe; and in such a case the results will indicate, if substantially uniform, in all cases not showing an excessive amount of moisture, the average quality of the steam within reasonable limits of errors of observation. Further, if the determinations obtained by the calorimeter in this position are irregular, or show large percentages of error, it may be reasonably

doubted that the sample of steam obtained is accurate. Fifth, a steam separator is always desirable to remove excess of water from the main steam pipe, in which case determinations should be taken after the steam has passed the separator. The writer, however, believes from his own experience that the use of the separator will not be found essential in one case out of twenty, for the reason that the water is very rarely thrown into the steam in larger quantities than the steam itself will take up and retain in a uniformly distributed condition.

Persouals.

Mr. G. W. Dickinson, General Manager of the Western lines of the Northern Pacific, has resigned.

General James Jourdan has been appointed temporary Receiver of the Kings County Elevated road.

Mr. C. O. Skidmore, Master Mechanic of the New York, Philadelphia & Norfolk Railroad, has resigned.

Mr. Charles W. McMeekin has been appointed Chief Engineer of the Iowa Central, with office at Marshalltown, Ia.

Mr. F. F. Graf has been appointed Receiver of the Ohio Southern Railroad in place of Mr. J. R. Megrue, resigned.

Mr. W. H. McDoel, General Manager of the Louisville, New Albany & Chicago, has been appointed Receiver of that road.

Mr. C. W. F. Felt has been appointed Chief Engineer on the Gulf, Colorado & Santa Fe Railroad with headquarters at Galveston.

Mr. R. P. C. Sanderson, Division Superintendent of Motive Power of the Norfolk & Western, has resigned, and that position has been abolished.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis.

Mr. J. H. McGill has been appointed Master Mechanic of the New Orleans and Northwestern and has charge of the locomotive and car departments and the water supply.

Mr. Henry Kistner has been appointed General Foreman of Motive Power and Car Department of the Monterey & Mexican Gulf Railroad, with headquarters at Monterey, Mex.

Mr. W. J. Miller has been appointed General Foreman of the Machinery Department of the Columbus, Sandusky & Hocking, at Columbus, O., to succeed Mr. P. T. Bancroft, resigned.

Mr. William Gibson, formerly Superintendent of the Cincinnati, Columbus and Sandusky divisions of the Big Four, has been appointed Assistant General Manager of the Baltimore & Ohio.

Mr. James Gaston has been appointed Master Car Builder of the Louisville, Evansville & St. Louis Railroad, with headquarters at Princeton, Ind. He takes the place of Mr. W. E. Looney, resigned.

Mr. W. H. Newman has accepted the position of Second Vice-President of the Great Northern and has resigned as Third Vice-President of the Chicago & Northwestern. His headquarters will be at St. Paul, Minn.

Mr. William Sinnott, formerly General Foreman of the Baltimore & Ohio shops at Philadelphia, has been appointed Division Master Mechanic of the Second and Third divisions, with headquarters at Cumberland, Md.

Mr. R. B. Burns, for years resident Engineer of the Atlantic & Pacific at Williams, Ariz., has been appointed Chief Engineer of that road, in charge of the maintenance of roadway and buildings, including service department.

Mr. J. G. Thomas, Assistant Superintendent of Motive Power and Equipment of the Central of New Jersey, with headquarters at Ashley, Pa., has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Mr. William H. Baldwin, Jr., has resigned the position of Second Vice-President of the Southern Railway to accept the Presidency of the Long Island Railroad, vice Mr. Austin Corbin, deceased. Mr. Baldwin will have his headquarters in New York.

Mr. W. G. Pearce, heretofore Assistant General Manager of the Northern Pacific, has been appointed Assistant General Superintendent of the reorganized road, with headquarters at Tacoma, Wash. Mr. Pearce will have jurisdiction over the lines west of Billings, Mont.

Mr. S. B. Hynes is General Manager of the Los Angeles Terminal Railway. Mr. William Wincup has resigned as Acting General Manager and Secretary, and Mr. F. K. Rule has been chosen Secretary. Mr. W. J. Cox has been appointed Assistant to the General Manager.

Mr. W. W. Finley, Second Vice-President of the Great Northern, has been elected Second Vice-President of the Southern, to succeed Mr. W. H. Baldwin, Jr. Mr. Finley was formerly Third Vice-President of the Southern, which position he resigned to return to the Great Northern, of which he had been previously General Traffic Manager.

Mr. W. H. Hudson, formerly Master Mechanic of the Southern Railway in Atlanta, has been appointed Master Mechanic at Salisbury, N. C. Mr. W. L. Tracy, formerly Master Mechanic at Birmingham, has been transferred to Atlanta, and Mr. W. A. Stone is transferred from Selma, Ala., to the position of Master Mechanic at Birmingham. Mr. Thos. M. Feeley takes charge at Selma.

Mr. E. H. McHenry, formerly Chief Engineer and lately one of the Receivers of the Northern Pacific, is now Chief Engineer of the reorganized road. Mr. W. L. Darling, who has been Chief Engineer since last April, has been appointed Division Engineer, with headquarters at St. Paul, Minn., in charge on lines east of Billings, Mont. C. S. Bihler is appointed Division Engineer, with headquarters at Tacoma, Wash., in charge on lines west of Billings, Mont.

J. F. Holloway.

Among a very large circle of friends and acquaintances the news of the death of the former President of the Society of Mechanical Engineers, which occurred at his home at Cuyahoga Falls, O., on September 1, was received with profound sorrow. His cheerful disposition, his hopefulness, his companionable nature, endeared him to all who had the privilege of his acquaintance. He was 71 years of age at the time of his death, which occurred after a brief illness, and was due to Bright's disease.

His business career was commenced in the works of the Cuyahoga Steam Furnace Company, in Cleveland. After his apprenticeship in this establishment he secured a place as Superintendent of a manufacturing company in Southern Illinois. He remained there until 1861, when he returned to Cleveland as Superintendent of the works in which he began his career. He occupied that position until 1872, when he was elected President of the company, which office he filled until the company went out of business in 1887. While occupying that position, it is said by a writer in the *Marine Review*, "By his industry, ingenuity and engineering skill, he assisted more than any man in laying the foundation of what is now regarded as the greatest merchant marine on any inland sea."

After the property of the Cuyahoga Company was sold, Mr. Holloway became associated with the Worthington Steam Pump Company, of New York, and remained there until about a year ago, when he became Consulting Engineer of the Snow Pump Company, of Buffalo, N. Y., which position he occupied at the time of his death.

He was one of the charter members of the American Society of Mechanical Engineers, and was elected President in 1884. He was also a member of the American Institute of Mining Engineers and of the Engineers' Club, of New York, and while a resident of Cleveland was a member of the Cleveland Civil Engineers' Society, of which he was at one time President. He often contributed papers to these associations, and took part in their discussions. He had the faculty of making what he wrote and said

interesting and easy of comprehension, which is not true of many of the contributors to engineering literature.

In the association of which he was a member he will be missed as long as those whose privilege it was to have his acquaintance will live. He always met them with a genial smile, and the sense of humor, which was one of his characteristics, attracted to him those into whose society he was thrown. Men who knew him best appreciated most the serious side of his character. With a long and varied experience in engineering, he had developed what may be called mechanical sagacity and a very sound judgment, which is of such great value in all engineering enterprises. In the words of the writer from whom we have already quoted, "One never failed to derive great benefit from his advice and pleasing suggestions, and yet the man of this disposition had the ability and capacity to manage successfully large engineering establishments, employing hundreds of men, whose confidence and esteem he enjoyed. He was held in the highest regard by his employees, and up to the time of his death had lost, among them still living, none of the good feeling that was due him from early years."

A wife, one son and one daughter survive him.

Equipment Notes.

The Baltimore & Ohio Railroad has received a large number of the 75 engines ordered several months ago.

The Northern Pacific is reported to have issued specifications for compound locomotives of special design.

The Chicago & Alton Railroad is building at its Bloomington shops 100 coal cars of 60,000 pounds capacity.

The Chicago, Rock Island & Pacific has given an order for 100 box cars to the Michigan-Peninsular Car Company.

The Baltimore & Ohio recently ordered a small electric locomotive for use in switching at the Baltimore terminals.

The Richmond Locomotive Works has orders for three 6-wheel connected engines for the Georgia & Alabama Railroad.

The Wabash is building two mail cars at its Toledo shops. The cars are 60 feet long and are equipped with Pintsch gas.

The Rogers Locomotive Works has been awarded a contract for three ten-wheel locomotives for the Keokuk & Western Railroad.

The Midland Terminal, of Colorado, has ordered two new engines and four new coaches for service between Cripple Creek and Gillett.

It is reported that the order for 100 refrigerator cars for Swift & Company, which was held up some time ago, will be let in the near future.

It is stated that the Pittsburgh Locomotive Works has orders for three 6-wheel connected engines from the China and Japan Trading Company.

It is reported that the Baldwin Locomotive Works has been awarded the contract for locomotives for the Tientsin & Peking Railway, which is a part of the Imperial Railway of China.

At the car shops of the Northern Pacific Railroad, South Tacoma, Wash., 120 new flat cars, of 70,000 pounds capacity, will be built in the next two months. The shops are also increasing the capacity of several hundred cars from 40,000 pounds to 50,000 pounds.

The Baltimore & Ohio Railroad put their new machine shops in Cumberland, Md., into operation last month. The shops cost \$340,000, including what is said to be the largest round house on the system.

The first shipment of motor cars for the New York and Brooklyn Bridge was received last month from the Pullman Car Company. The new cars are fitted with heavy motors, also a cable grip. The cars were run on their own trucks from Chicago. Each train over the bridge will have one of these motor cars attached for switching at the terminals.

The Fire-Retarding Qualities of Wired-Glass.

In a paper on the fire-retarding qualities of wired-glass, by C. A. Hexamer, C. E., in the Journal of the Franklin Institute for August, there is given the result of a test of wired-glass made at the request of the Mississippi Glass Company, and reported to the Philadelphia Fire Underwriters' Association. Briefly told the test is as follows: A brick test-house, about 3 by 4 feet, inside measurement, and nine feet high, was constructed in the yard of the Pennsylvania Iron Works. In one side of this structure a wired-glass window was fastened in a wooden frame, covered with lock-jointed tin. In another side, a Philadelphia standard fire-door was hung. The upper part of this door had a pane of wired-glass, 18 by 24 inches, set into a wooden metal-covered frame. The entire roof of the test-house was replaced by a skylight, the sash being constructed of wood, metal-covered; one side of this skylight being provided with three lights of $\frac{1}{4}$ -inch ordinary rough glass, the other side with three lights of wired-glass. The wired-glass used was $\frac{1}{4}$ inch thick, and was manufactured by the Mississippi Glass Company, of St. Louis. Iron grate bars were placed in the bottom of the test-house, and openings were left in the wall near the ground for free draught. The test house was filled for two-thirds of its height with wood treated with a liberal allowance of coal oil and resin. In a few minutes after the fire was started the ordinary rough glass in the skylight cracked and pieces began to fall into the fire. The wired-glass in the fire-door soon became red hot, also the three plates of wired-glass in skylight, but they retained their positions throughout the test. At the end of 30 minutes, water was thrown on the fire and also on the hot glass. After the fire was extinguished, the three plates of glass in the skylight were found to be cracked into countless pieces, but still adhering together, forming one sheet. The window light, which, as the result showed, was not properly secured to the frame, was found to be in same condition as skylight glass, except that a large crack had developed. The plate of glass in the standard fire-door was cracked, the same as the skylight; but having been well secured into the door frame, it did not give way. The action of the fire on the wooden metal-covered skylight and window frame showed conclusively that this class of construction is far superior to iron framing, no warping or giving way of any portion of the frames being noticed. The fire door in direct contact with the fire showed but little buckling on the inner side, and no signs of giving way. On removing the tin covering, it was found, however, that the inner layer of 1-inch boards was completely charred through, but that the second layer was only slightly damaged.

The conclusions to be drawn from the test appear to be as follows:

(1) Wired-glass can safely be used in skylights, and in such situations will withstand a severe fire and will not give way when water is thrown on it. A wooden framing for skylight, covered with tin, all seams lock-jointed and concealed-nailed, is superior in fire-resisting quality to iron framing.

(2) Wired-glass in wooden sash, covered with tin, all seams lock-jointed and concealed-nailed, can safely be used for windows toward an external exposure.

(3) Wired-glass can safely be used in fire-doors to elevator shafts and stairway towers, where it is necessary to light said shafts.

(4) In office buildings, hotels, etc., where it is undesirable to have elevator shafts entirely enclosed and dark, wired-glass permanently built into a brick or terra-cotta shaft, or arranged in a wood metal-covered frame, can safely be used.

(5) Wired-glass plates, securely fastened in standard fire-shutters, can safely be used toward an external exposure.* In this case, the fact that a possible fire in a building, all windows of which are protected by fire-shutters, can much more readily be detected from the outside through the wired-glass, is of importance.

Why an Electric Motor Revolves.*

The action of the current in producing rotation in an electric motor is quite simple.

The fundamental fact is the relation between an electric current and a magnet. If a piece of iron be surrounded by a coil through which current is passed, it becomes a magnet. It will attract iron, and the space surrounding it becomes magnetic. Iron filings will arrange themselves in the direction shown by the dotted lines in Fig. 1. One end of a magnet is a north pole and the other a south pole.

If a wire, such as *CD*, be moved past either pole of the magnet, there will be a tendency for current to flow in the wire either from *C* to *D* or from *D* to *C*, according to the character of the pole past which it is moved and to the direction of the movement. If the ends of the wire *CD* are joined by a conductor, so that there is a complete circuit, a current of electricity will flow through the circuit.

The reason why there is a tendency for an electric current to flow in the wire *CD* when it is moved in the vicinity of a magnet is not known. There are several theories, all more or less involved and depending upon pure assumptions as to the nature of an electric current. For all practical purposes it matters not what the reason is; the fact that current flows when there is an electric pressure in a closed circuit is the important thing, and it serves all useful pur-

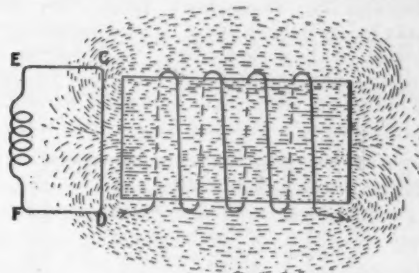


Fig. 1.

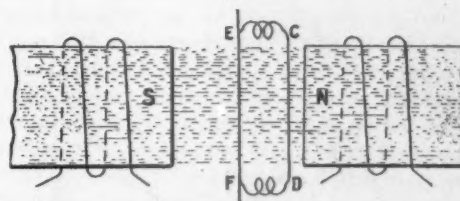


Fig. 2.

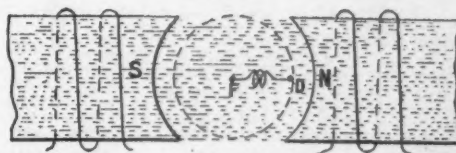


Fig. 3.

poses to know that current does flow, and that its direction and amount are always the same under similar circumstances.

The intensity of the electric pressure, or electro-motive force, depends upon the velocity of revolution of the wires and upon the strength of the magnets, and the quantity of current depends upon the electro-motive force and upon the amount of the resistance in the circuit. Other things being equal, the current through a long small wire, or greater resistance, will be less than through a short thick one, or a less resistance.

Two electro-magnets are shown in Fig. 2, in which the north pole of one magnet is near the south pole of the other, and the magnetic field between the two lies in approximately straight lines between the two magnets, as indicated by the dotted lines. If the wire *CD* be moved across this field and its ends be joined, as by the circuit *CEFD*, a current will flow in this circuit. The wire *CD* may be made to revolve around the wire *EF*, passing in front of one pole and then in front of the other pole, as in Fig. 3. The current in the circuit will pass in one direction when the wire is passing one pole, and in the other direction when it is passing the other

* From a pamphlet or catalogue of electric locomotives, issued by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company, and written by Mr. D. L. Barnes.

pole. The connection between this elementary arrangement and the dynamo is easily recognized. In the dynamo a magnetic field is produced by electro-magnets called "field poles," and a considerable number of wires similar to the wire *CD* are placed upon an armature so that they revolve in front of the poles. Each individual wire produces current first in one direction and then in another direction, as explained above; but if there be many wires, there will always be the same number in front of the positive pole and the same number in front of the negative pole, so that the total or resultant action is practically uniform and may be made to produce a continuous current. Such a machine is the common dynamo or motor.

A dynamo transforms mechanical into electrical energy, and a motor transforms electrical into mechanical energy. The two operations are reversible and may be effected in the same machine; a dynamo may be used as a motor or a motor may become a dynamo. A machine is a motor when it is driven by a current of electricity, and it is a dynamo when it is driven by mechanical power and produces an electric current. A simple form of electric machine is shown in Fig. 4, which is the general form of the electric motor. In this there are two projections of steel, *H* and *G*, which are made electro-magnets by the current going through the wires wound around them from any source of electricity, such as a battery at *I* and *J*. These magnets have poles facing toward a drum, *K*, revolving on a shaft. The poles *G* and *H* are called the "salient" poles; the other two the "consequent" poles. The magnetic flow or field is shown by the dotted lines. On the periphery of the drum are arranged wires in the slots shown. As this drum is revolved, there will be a tendency for electricity to flow in the wires. In order to get a current of electricity from these wires it is necessary to make a complete circuit. As each of the wires in the slots passes

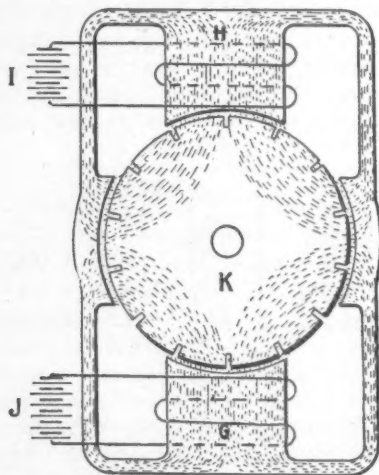


Fig. 4.

in front of a pole, a pressure or electro-motive force will be generated, and its direction will depend upon whether the pole is a north or a south pole.

The pressure or electro-motive force generated in the wires moving in front of the positive or north field poles will be in one direction, while those in front of the negative or south poles will be in the opposite direction. Therefore, if two such wires be connected together at one end of the armature, the free terminals of the wire at the other end of the armature will have the sum of the electro-motive forces generated in the two wires. The wires so connected can be considered as a turn of a single wire, instead of two separate wires, and this turn may be connected in series with other turns, so that the resulting electro-motive force is the sum of that in all the turns and all the wires so connected. It is customary to connect the coils of an armature so that the electro-motive force given is that obtained from half the coils in series. The other half of the coils is connected in parallel with the first half, so that the currents flowing in the two halves will unite to give a current in the external circuit equal to twice the current in the two armature circuits or paths.

It is evident that, as the armature revolves, wires which were in front of the positive pole will pass in front of the negative pole, and that in order to maintain the electro-motive force it will be necessary to change the connections from the armature winding to the external circuit in such a way that all the wires between the two points of connection will have their electro-motive forces in the

proper direction. The connection to the armature must therefore be made not a definite point in the armature itself, but at a definite point with reference to the field magnets, so that all the wires between two points or contacts shall always sustain the same relation to the field magnets.

For this purpose a device known as a "commutator" is provided. The commutator is made of a number of segments, as shown at *A*, in Fig. 5, which are connected to the armature winding. On the commutator are sliding contacts, or brushes, which bear on the segments and are joined to an external circuit, making a continuous path through which current may flow. As the commutator revolves the different segments come under the brushes, so that the relative position of the armature wires between the brushes is dependent on the position of the brushes. The armature wires which connect the brushes are those sustaining the desired definite position to the field magnets, so that the currents from the armature at all times flow properly into the external circuit, although indi-

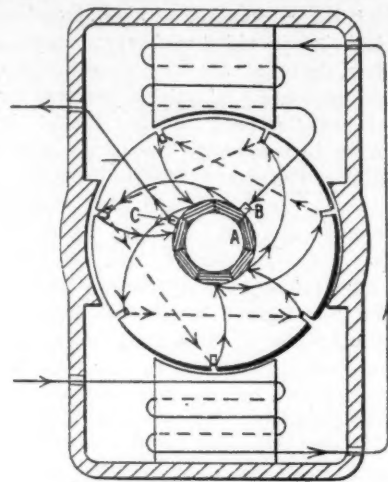


Fig. 5.

vidual armature wires carry currents first in one direction and then in the other direction, depending on the character of the pole in front of which they may be moving.

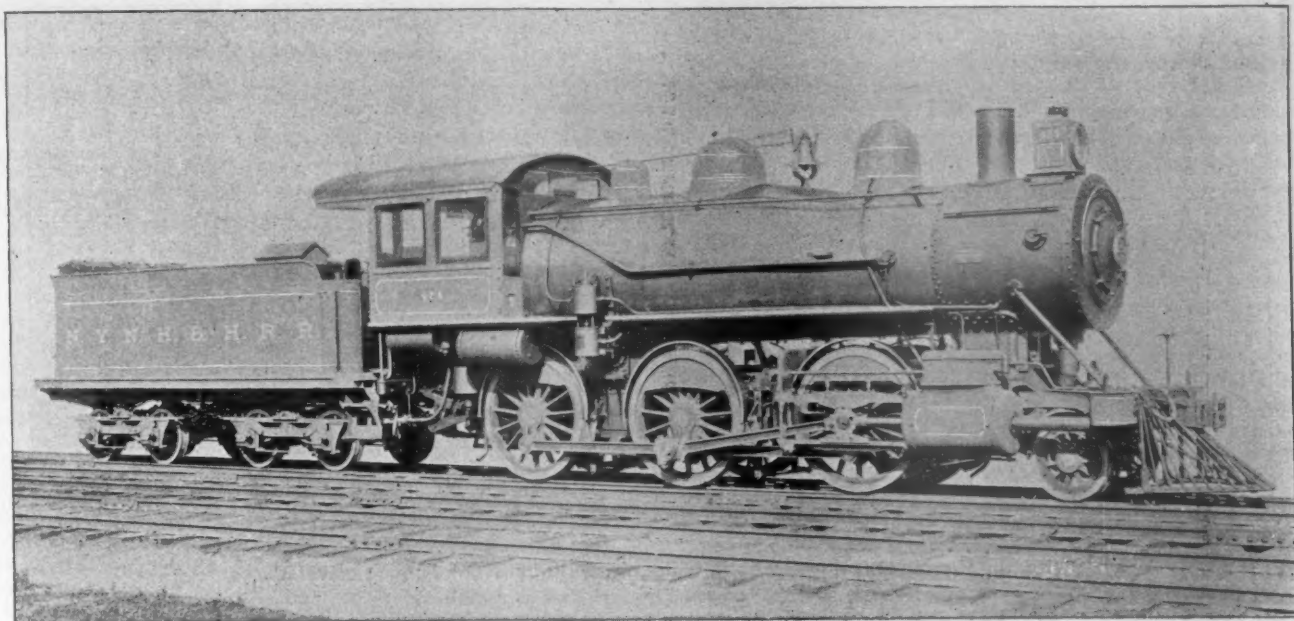
On two-pole machines there are two brush-holders, each containing one or more brushes. On the four-pole machine there may be either two or four brush-holders, and on a six-pole machine, either two, four or six brush-holders.

A single path of the current through the commutator and armature winding is shown by the arrows on Fig. 5. The brushes *B* and *C* are placed on the top side of the commutator to make them more accessible, and this gives a peculiar but simple armature winding.

For the sake of simplicity, the batteries *I* and *J* of Fig. 4 are not used on common forms of generators or motors, but the current that flows from the armature through the commutator is made to flow through the electro-magnets either in whole or in part. If all of the armature current flows around the electro-magnets or fields of the machine, it is a "series" machine; if only a part of the current is used in this way, it is a "shunt" machine, that is, some of the current is "shunted" through the fields. Sometimes both the shunt and series windings are used, and in that case the machine is called a "compound wound" machine. Such a machine has a large wire through which the main current passes, and a fine wire through which the shunted current flows. Fig. 5 shows how the commutator and the fields are connected, and how the current flows from the wires in the armature through the commutator in a series machine.

If the current delivered by a dynamo does not flow in the desired direction, it can be reversed by shifting the wires in the binding posts or by throwing a switch. If the motor does not revolve in the desired direction, it can be made to do so by reversing the connections to the armature or field-coils; so that, without knowing which way a current of electricity is to be generated, any practical man can make a motor revolve in a proper direction by simply changing the connections.

It is natural that a machine which gives out electric energy when driven by an external power will, when electric energy is delivered to it, reverse its action and give out mechanical power and do work. This is not a logical reason why a motor revolves under the influence of an electric current, but it is a natural inference which assists in comprehending the fact.



Mogul Freight Locomotive for the New York, New Haven & Hartford R. R.—Built by Schenectady Locomotive Works.

Perhaps the simplest way to explain the cause of the movement of an electric motor, when supplied with a current, is to compare the action to the well-known attraction of unlike poles or magnets and the repulsion of like poles. In any motor the current through the field causes a north or south pole to be maintained, and the current through the armature and brushes causes an opposite polarity. These constantly maintained unlike poles attract each other and pull the armature around on its axis.

It has been explained that if a motor be driven by a belt an electro-motive force is produced and the machine acts as a dynamo. It is also a fact that an electro-motive force is produced whether the power for driving the machine is obtained from a belt or from the electric current—that is, whether the machine be driven as a dynamo or as a motor. In a dynamo, however, the current flows out in the direction in which the electro motive force is acting. In a motor the electro-motive force produced has a direction opposed to the the direction of the flow of current. This may be illustrated by the following experiment:

Two similar machines are driven independently at 600 revolutions and give an electro-motive force of 100 volts. Similar terminals of the two machines are connected together. No current flows between the machines because the two pressures are the same and are opposed in direction. If now the belt be thrown off from one machine its speed will begin to fall. This will lower its electro-motive force below that of the other machine or dynamo, but will not change the direction of the force. There will now be a difference of pressure in favor of the machine which is driven, and it will now send a current through the other machine and run it as a motor. The speed of the motor will continue to fall until the difference in pressure or electro-motive force between the two machines is just sufficient to cause the flow of enough current to keep the motor running against whatever frictional resistance and other resistance there may be. The electro-motive force generated in the motor, which is against or counter to that of the current in the circuit, is called the "counter electro-motive force."

In order to determine how fast a motor will run without doing work under any given pressure, it is not necessary to know anything about the dynamo that furnishes the pressure. The pressure alone is sufficient to determine the speed of the motor. For instance, if a motor will give a pressure of 500 volts when running free at 100 revolutions, it will always run at about 100 revolutions when not doing work on any electric circuit where the pressure is 500 volts.

This description of a motor or dynamo carries with it all of the fundamental theory of electrical generators and motors that it is necessary for a mechanic to know in order to take reasonably intelligent care of electric locomotives. Further useful knowledge must be attained by studying the different types of electric motors and dynamos. These other types all have the same fundamental theory, even when the construction is quite different.

Mogul Freight Locomotive—New York, New Haven & Hartford R. R.

We show in the accompanying engraving one of ten mogul freight locomotives which the Schenectady Locomotive Works recently built for the New York, New Haven & Hartford R. R., from specifications prepared by Mr. John Henney, Superintendent of Motive Power. They have cylinders 20 inches by 28 inches, and driving wheels 63 inches in diameter. The driving wheel centers are of cast steel, as are also the pistons, foot plate and driving boxes. Pressed steel is used for the boiler front and door, cylinder head casings, dome ring, dome cap and dome casing. The flanging of boiler plates is done on an hydraulic flanging press. The arrangement of cab is the same as on the 20 inch by 24-inch passenger engines recently sent to the same company, and gives very comfortable quarters for the engineer and fireman.

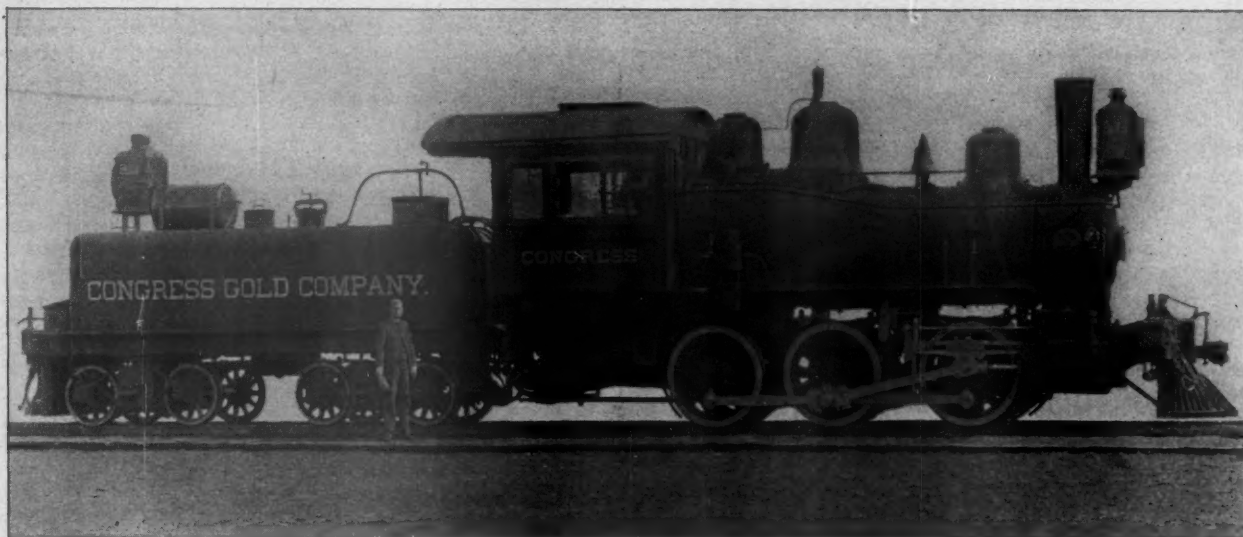
From the data given below it will be seen that the engine has great power and weight—124,450 lbs. on three pairs of drivers being about 41,500 lbs. per pair.

Cylinders.....	20 inches by 28 inches
Driving wheels.....	63 inches
Driving wheel base.....	15 feet 2 inches
Total wheel base of engine.....	23 feet 3 inches
Weight on drivers.....	124,400 pounds
Total weight of engine in working order.....	144,200 pounds
Boiler, diameter.....	62 3/4 inches
Firebox.....	108 1/2 by 40 1/4 inches
Tubes, number of.....	312
" size of.....	2 inches O. D. by 12 feet
Heating surface, tubes.....	1,946.72 square feet
" firebox.....	164.38 square feet
" total.....	2,111.10 square feet
Boiler pressure.....	180 pounds
Grate area.....	30.22 square feet

The tank has a capacity of 4,500 gallons and the tender will carry 8 1/2 tons of coal. The boilers are of carbon steel, and among the fittings might be mentioned Metropolitan injectors, consolidated safety valves, magnesia sectional boiler covering, Westinghouse brakes, Paige steel-tired truck-wheels, Richardson balanced valves and Jerome metallic packing.

Western Railway Club.

The September meeting of the Western Railway Club was held on the 15th, and was followed in the evening by the annual banquet. At the meeting the paper of Mr. D. L. Barnes, on the power and efficiency of electric locomotives, was discussed, also the paper of Prof. Goss on the performances of the Purdue locomotive, both of which papers were read at the May meeting. A committee was appointed to suggest at the next meeting remedies for certain difficulties that had come up under the new rules of interchange. Mr. E. M. Herr led the discussion on "Difficulties with the Use of Metal Underframes for Tenders and Cars." A paper on the "Apprentice Boy" was read by Mr. J. N. Barr.



Switching Engine Burning Crude Petroleum.—Built by Brooks Locomotive Works.

At the banquet several excellent addresses were made. President Waitt, speaking on "Our Club," said, in part:

We cannot as a club look back on long years of work, the organization being to-night but 12 years and five months old. We cannot boast the largest membership, for our newly born sister club at St. Louis has for the time being outnumbered us. But the Western Railway Club can with pride look back over 12 years' work and point to some of the most valuable papers, from both a technical and practical standpoint, that have ever emanated from any similar organization. The Western Railway Club has been peculiarly fortunate in its membership. It is with great satisfaction that we are able to point to the fact that we have among our active members a large number of men fortified by a thorough technical training which has been supplemented by years of practical work, enabling them to bring to the deliberations of our club the sound reasoning and good judgment for which our work has for many years been noted. . . . As we look with pride on the past we should not stop satisfied.

Colonel H. G. Prout, of the *Railroad Gazette*, responding to "The Press," alluded to the railroad profession and then questioned if he was exactly right in using the term "profession." He believed, however, that the professional spirit was on the increase. He said, in part:

I like to think that the professional spirit is growing fast among railroad officers. Whether or not railroading is a profession; whether or not it ever can be a profession, is a small matter and the vital thing is that railroad officers should have the professional spirit. We must look to this spirit to save the railroads from the ignorant and corrupt subordinate. We must look to it to save the railroads from the brigands in high places seeking only to make their own fortunes. Perhaps we must look to it to save the railroads from confiscation by Socialists and Populists, and, in fact, by honest voters who would come to be classed with either. How the professional spirit will do all this I need not point out. It will administer the properties for the interest of their owners and not for the profit of salaried officers. But, in the long run the interest of the owners is the interest of the public, and thus we find the probable solution of much that is most troublesome in what is called the railroad problem.

Other speakers were President Lemont, of Purdue University. Mr. J. H. P. Hughart, Second Vice-President, and General Manager of the Grand Rapids & Indiana Railroad; Mr. M. C. Markham, Assistant Traffic Manager of the Illinois Central; Mr. F. W. Morse, of the Grand Trunk; Mr. Geo. H. Heafford, Mr. H. C. Buhoup and Mr. E. B. Leigh. A straw vote for the presidential candidates resulted thus: McKinley, 89; Palmer, 4; Bryan, 0.

Locomotive for Burning Petroleum Fuel.—Built by the Brooks' Locomotive Works.

In the accompanying illustration we show an interesting engine recently built by the Brooks' Locomotive Works, Dunkirk, New York. It is a six-wheeled switching locomotive for the Congress Gold Company, of Congress, Ariz., and is equipped for the use of crude petroleum as fuel. The details of the oil burning specialties are not fully covered by patents and therefore we are not at liberty to publish them at present, but we expect to place them before our readers in the near future. The engine has cylinders 17 inches by 24 inches, driving wheels 51 inches in diameter, a boiler 56 inches in diameter, a firebox 78 inches by 82 inches, a driving wheel base of 11 feet, and a total

wheel base of 46 feet 6 inches, including tender. The total weight of the engine alone in working order is 112,000 pounds. The boiler pressure is 180 pounds. The tank capacity is 3,600 gallons of water and the oil tank will hold about five tons of petroleum. The engine is fitted with Jerome metallic packing, Nathan injectors and cylinder lubricator, McKee-Fulla steel tired wheels under tender, National brake beams, Cooke bell ringers, Westinghouse brake and train signal, also the Le Chatelier water brake, Janney couplers, Tilden wrecking frogs and the Nathan fire extinguisher.

Electric and Compressed-Air Locomotives for the Manhattan Elevated.

The electric locomotive which the Manhattan Elevated Railway will try upon the Thirty-fourth street branch of its lines is now complete. It has the same arrangement of running gear as the present steam locomotives on the road, there being two pairs of drivers and a four-wheeled truck.

There is a motor on each driving axle. The motors will take current from a third rail, but the locomotive carries a large number of storage batteries which will be charged from the third rail when the current required for the motor is below a certain amount and which will automatically furnish current to the motor, in addition to what the latter receives from the third rail when the demands on the motor are heavy. In this way the batteries take care of the "peak" of the loads.

The company is also about to try a compressed-air motor of the Hardie type. This is now building at Rome, N. Y. We understand that both the compressed-air and electric locomotives will weigh slightly more than the present steam locomotives.

The British Admiralty have ordered the stern torpedo tubes to be taken out of all ships of the *Royal Sovereign* class, and these vessels will now carry only the submerged tubes. There are two very substantial reasons for this course. Experiments have been made which have demonstrated the possibility of hitting the whiskers of a torpedo by means of quick-firing guns while the weapon is in the tube and thus hoisting the engineer with his own petard. Then (says the *Naval and Military Record*) it has been found on the China station that where the stern tube is reasonably near the water-line the seas in rough weather fill the tube, and, if the torpedo is there, collapse the balance chamber. The trials of the *Eclipse* were especially directed to elucidate this point, but though no accident occurred in that cruiser, owing to her tube being well out of the water, an immunity from accident is not guaranteed to ships less favorably constructed. Hence the necessity that has arisen for removing the tubes.—*Exchange*

The New Battle-Ships.

The bids for three new battle-ships authorized by Congress at its last session were opened in Washington on Sept. 14. The bids were as follows:

John H. Dialogue & Sons, Camden, N. J., one battle-ship for \$2,661,000.

Bath Iron Works, Bath, Me., one battle-ship for \$2,680,000.

Newport News Shipbuilding and Dry Dock Company, Newport News, Va., one battle-ship for \$2,595,000.

Union Iron Works of San Francisco, one battle-ship for \$2,674,950.

William Cramps & Sons' Ship and Engine Company, Philadelphia, one battle-ship for \$2,650,000; two battle-ships for \$2,650,000 each.

As a difference of 4 per cent. in favor of Pacific coast builders has always been allowed on account of the cost of transporting materials across the continent and to offset the voyage of the Atlantic-built ships to the Pacific for duty on that ocean, this must be deducted for the purpose of comparison, thus bringing the San Francisco bid down to \$2,598,982, or within \$3,952 of the lowest bid, and considerably under that of the Cramps.

The result of the bidding is that the Newport News Company, the Union Iron Works and Wm. Cramps & Sons Company will each build one ship.

These battle-ships are to be the most powerful yet constructed for our navy. In size, displacement and general characteristics the new vessels will not be much different from the *Indiana*. The total length on the water line will be 368 feet, or only a few feet longer than the *Indiana* class, while their extreme beam will be 72 feet 2½ inches, which makes them the widest battle-ships in the navy. Their freeboard, 19¼ feet, will also be a little above that of battle-ships of their class, and as the guns will be several feet above the decks, their fire is expected to be as efficient as the batteries of the *Kearsarge* and *Kentucky* type, with their great superposed turrets mounting 8-inch guns above the 13-inch rifles. The freeboard aft is 6 feet below its extreme height forward. The normal displacement is given as 11,525 tons, but it will approximate 12,000 tons when the ships are in actual service and ready for fighting. The displacement is about the same as that of the *Kearsarge* type.

To propel these vessels 10,000 horse power will be required to give them an estimated speed of 16 knots in a seaway. In this respect the vessels are supposed to be one knot better than the *Indiana* type, whose plans only called for 15 knots an hour on a four hours' run. The normal coal supply will be 300 tons, and the maximum bunker capacity 1,200, the latter supply enabling the big ships to have a wide radius of action at a 10-knot speed.

In the batteries of these ships the ordnance officers have endeavored to present the largest quantity of heavy ordnance carried by any ships of their class afloat. The arrangement of the guns, especially those of the secondary battery, is the best for raking fire yet designed, and, while there has been a departure in the assignment of ordnance from that followed in the *Indiana* class in doing away with 8-inch guns in order to increase the number of lighter guns, it is not believed that the power of the ship as a fighter will suffer. The main battery will consist of four 13-inch rifles mounted in two turrets, fore and aft, and fourteen 6-inch rapid-fire guns arranged in broadside. The secondary battery comprises sixteen 6 pounders, four 1-pounders, four machine guns and one field gun.

The engines are of the triple-expansion type and they drive twin screws. The cylinders will be 34, 50 and 78 inches in diameter, and have a stroke of 48 inches. To generate the steam necessary to develop the required horse power there will be eight large boilers with a total grate surface of 685 square feet. The working pressure will be 180 pounds. The armor belt will be of Harveyized steel 16½ inches thick and 7½ feet deep.

Statistics recently published at Munich show that there are in operation in Central Europe, 15,644 gas engines aggregating 52,694 horse power.

The Spontaneous Ignition of Coal.

The following interesting extract is taken from *Kuhlou's German Trade Review*, and it is interesting to notice that Professor Dr. Medem traces spontaneous ignition to the oxidation of iron pyrites, and as no coal is entirely free from this sulphide of iron, the cases the doctor brings under notice become all the more interesting.

Professor Dr. Medem, in the course of a treatise on the spontaneous combustion of hay and coal, gives the following account of the causes this phenomenon and methods that have been proposed for its prevention and suppression.

The simplest form of spontaneous ignition is exhibited by dry spongy platinum, and is due to the absorption and condensation of oxygen in the pores of the metal. When exposed to a current of hydrogen gas, chemical combination immediately sets in, raising the temperature sufficiently to ignite the stream of hydrogen.

In the case of charcoal, a pyrophoric tendency is only manifested when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character if powdered so that the internal layers are enabled to absorb oxygen. As the process of chemical combination always goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out, since attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion. Every time the charcoal is broken up the danger of ignition will recur, down to the time it is ground to powder, but powdered charcoal once "killed" by exposure to air never regains its pyrophoric properties.

Hard coals, brown coals and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of fire-damp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal, when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass, and accordingly the coal is stacked as tightly as possible in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1836, and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than 97 coal laden vessels have been destroyed and the lives of some 2,000 seamen sacrificed through spontaneous ignition of the cargo.—*Colliery Engineer*.

Central Railroad Club.

At the September meeting of the Central Railroad Club the Committee on Car Roofs made a report, also the Committee on Planished Iron vs. Plain Sheet Iron or Steel for Locomotive Boiler Jackets. Part of the latter report is as follows:

We find that the difference between the first cost in material of planished iron and plain sheet iron or steel, for the jacket of an engine, to vary considerably, running from \$31.61 to \$37, in favor of the plain sheet-iron or steel jacket.

We also find practically the same difference between the total cost of labor and material of the planished iron and plain sheet iron or steel jacket, as applied to an engine, the difference running from \$20.14 to \$37, in favor of the plain sheet-iron or steel jacket.

The life of a planished iron jacket when placed on a good boiler covering, and with proper care taken of it, would be from eight to ten years, and during this time, when the gloss is worn off, or the condition of the jacket should warrant it, it can be then painted, and be maintained at the same cost as the sheet-iron or steel jacket.

We have no information or facts showing the life of a sheet iron or steel jacket.

The cost of maintenance is a difficult question to answer. The planished iron jacket is cared for by the fireman, and he must use some material to keep it clean and protect the jacket from injury from water and drippings from roundhouse, etc., and we are strongly of the opinion that the cost of material to take care of the planished iron jacket will keep a sheet-iron or steel jacket painted. We find from the replies received that to keep the sheet-iron or steel jacket in good condition, they will require two coats of paint a year, at an annual cost of about \$5.

This report and the one on car roofs (which we have not yet received) will be discussed at the next meeting. The report on tool rooms presented at the May meeting was passed without discussion. The new interchange rules were discussed at some length from which it appears that rulings of the Arbitration Committee on certain matters is required at once. There is a conflict of opinion in regard to the interpretation of the rule covering "wrong repairs." A resolution was passed as follows:

"When cars are interchanged having M. C. B. repair cards attached, and also having improper repairs not covered by M. C. B. defect cards, that the repair card be sufficient authority to pass the car to the owning road; and, further, that cars in interchange found with improper repairs and no M. C. B. repair card or defect card attached, that the policy now outlined at Buffalo is to take a record of such wrong repairs when it is possible to distinguish them and that record shall be all the evidence necessary and that all the action necessary at any interchange point to pass that car home to the owning road."

Section 48 of Rule 3 will be interpreted by the members as though the word "simultaneously" had been printed before the last two paragraphs.

President Bronner announced the following subjects and committees for the meeting in November:

"What is the best plan to bring about the adoption of M. C. B. standards by railroads?" Committee: A. M. Waitt, G. W. West, R. S. Miller, James Macbeth, William McWood, John S. Lentz.

"Apprentice boys in railroad shops." Committee: S. Higgins, M. L. Flynn, E. D. Nelson, W. G. Taber, N. Lavery, John Mackenzie.

H. H. Perkins, Local Freight Agent of the New York Central, is also to read a paper on this topic: "Shall the cubic capacity of ordinary box cars be increased, and if so, what should be the maximum limit?"

American Society of Irrigation Engineers.

The annual meeting of this society will be held in Denver, Dec. 11 and 12, closing in time to reach Phoenix for the opening of the International Irrigation Congress on the 15th of that month. At the meeting State Engineer Mead, of Wyoming, will present a paper on "Land Laws for Arid Regions." "Pipes vs. Flumes" will be another principal subject. These papers will be printed and distributed in advance for discussion, and a circular will also shortly be issued giving full particulars of the programme for the meeting. J. S. Titcomb, Jacobson Building, Denver, is secretary.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 234.)

We thus see without any further explanation that with the smaller nozzle distances the shallowest (.31-inch) bridge is the better; at greater distances the second and at the greatest distances the deepest or 1.89-inch bridge is the best. The conclusion to be drawn from this is that with the .31-inch bridge the angle of deflection for the portion of the steam jet above the nozzle, and consequently its sectional area, is greater than that of those varying from .63 inches to 1.89 inches in depth. A larger sectional area of the jet must, with a shorter nozzle distance, force the vacuum more strongly than one of a smaller area would do, but it also fills the smallest sectional area of the stack more quickly, and consequently will begin to drop away from the full value of the vacuum earlier than a jet of smaller sectional area. This explains the earlier attainment of the highest point and also the earlier dropping away of the curve as compared with that of the bridges .94 inch and 1.89 inches deep.

If, in the graphical representation under II. of Plate VII., those nozzle distances fall short of giving the better results, especially in connection with the shallow bridge and the funnel-shaped stacks than they do for the waist stacks, the reason is to be found in the fact of the bad connection of the steam and the entrained air, as was explained at the close of Section IV.

Finally an effort was made to determine whether it were better to have the top of the bridge flush with the top of the nozzle or allow it to project above the same. For this purpose the two nozzles shown in Fig. 62 were used. Their diameters were 5.12 inches and 4.94 inches respectively, and while they had the same free opening, the bridges were set at different heights. The results are given in Plate VII. under III. We see that a somewhat better result was obtained with the flush bridge, which is due to the greater surface of the jet of steam issuing from the nozzle 5.12 inches in diameter.

VIII.—FORM AND DIVERGENCE OF THE STEAM JET.

In order to accurately determine the effect of the bridge upon the shape of the steam jet and thus draw a correct conclusion regarding the cause of the increase of draft as well as the lessening of the same by a contraction of the stack, an investigation was made to ascertain what might be the form and size of the steam jet issuing from the nozzle of the apparatus. It was accomplished by using the rings that had been employed for changing the nozzle positions and setting them on top of one another, the lowest first and so on up to the highest, and then putting the lowest on this, and at each change allowing steam to blow out under the same pressure as in

the smokestack experiments. This showed that the lower portion of the jet for a length of about 19.68 inches is in the form of a smooth truncated cone, which from measurements taken near the nozzle opening has a somewhat sharper flare than at greater distances, as shown by the last column of table XXV., and which further on appears to become first weaker and then rougher and more broken up on the outer surface.

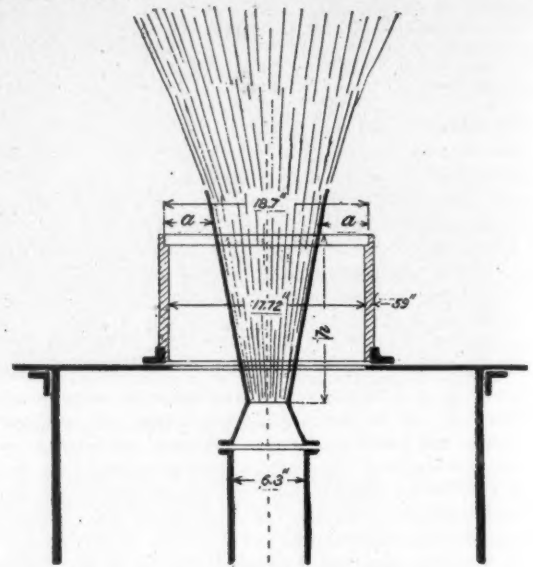


Fig. 63.

The distances, indicated by a in Fig. 63 from the edge of the ring to the steam jet, were now measured at four points that were opposite each other, and this was done for the different heights of rings up to 25.79 inches above the nozzle opening, and from it the diameter of the steam jet was calculated at four different heights. The last was found to be in exactly the same condition within the ring as in the smokestack experiments. These measurements were taken for all five nozzle diameters, and it was found that the diameter of the jet increases with the increasing diameter of the nozzle opening as that diameter itself increases. The jet on leaving the nozzle has the same diameter as the latter; at least no difference could be detected.

The shape of the jet undergoes almost no change at different steam pressures; with the higher pressure the lower smooth portion is merely lengthened a trifle, which means that the broken surface of the outside appears at a somewhat greater distance from the nozzle opening. The relation of the stack to the different nozzle pressures is dependent upon this very fact, as we have already explained in Section II.

The five foregoing measurements of the steam jet are grouped together in Table XXIV., from which the averages for the jet diameters as given in Table XXV. are obtained.

It will be seen from these tables that exact measurements amid that loud and almost intolerable noise of a large steam jet was not practicable, since it was not possible to bring the rule in direct contact with the rapid current of exhaust steam. This explains the difference between the bracketed figures and the actual maximum measurements of Table XXIV.

According to Table XXV. the diameter of the section of the jet for all five nozzles increases in an arithmetical ratio with them, so that, at the same heights, the section is increased by the same coefficient. At a distance of 25.79 inches from the nozzle this increase in all five cases amounts to 10.67 inches, from which we see that the average flare of the jet is

$$1 : \frac{25.79}{10.67} = 1 : 2.41,$$

which means that the conical sides of a continuous current of steam are inclined to a vertical at an angle of 1 in 4.8, as shown in Fig. 64.

Figure 65 shows the form of a jet as it issues from a nozzle 4.72 inches in diameter. If this is drawn full size and the outlines ac and bd plotted, it will be seen that these latter vary only very slightly from the actual outlines. The sharpest relative flare naturally occurs in the lower portion of the jet, which is shown by the last column of Table XXV. to be 1 in 2.2 instead of 1 in 2.4. At a height of 15.75 inches the flare of the outer surface becomes 1 in 2.34, and at 19.68 inches it is 1 in 2.39. Now, since in the general

* Paper read before the German Society of Mechanical Engineers, and published in *Glaser's Annalen für Gewerbe und Bauwesen*.

A. FULL LENGTH STACK

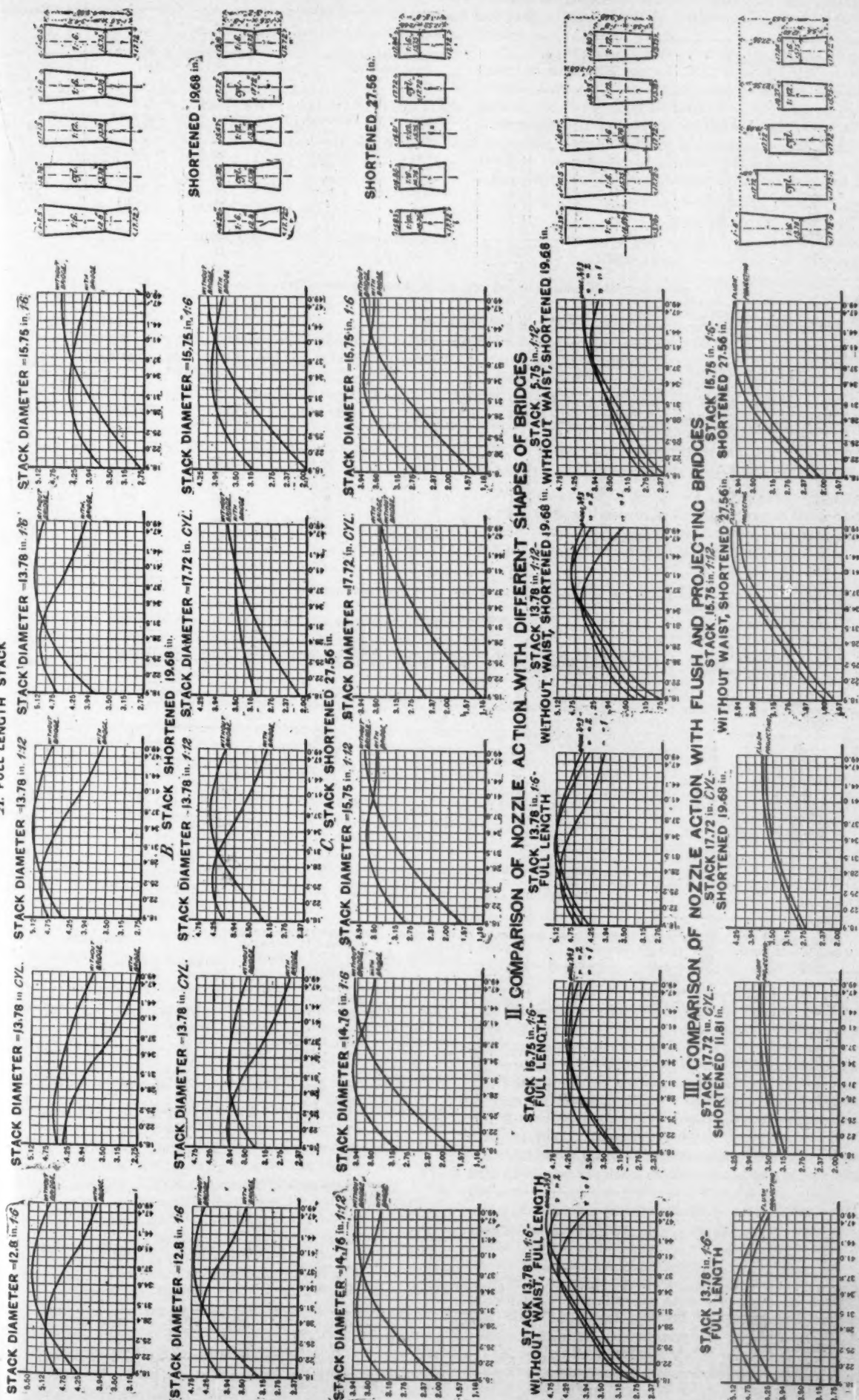
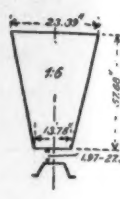


PLATE VII.—DETAIL DIAGRAM OF THE HANOVER SMOKE STACK AND EXHAUST NOZZLE EXPERIMENTS.


REMARKS.—1. The abelases, which indicates the nozzle distances, for stacks that have no waist and for the cylindrical stacks 17.72 inches in diameter, are measured from a zero point 17.52 inches above the smallest cross section which is at the bottom of the stack proper, and 18.9 inches above the highest position of the nozzle.

2. In the experiments tabulated under L, the nozzle without a bridge had a diameter of 4.74 inches, while that of the one with a bridge was 5.12 inches. The width of the bridge was .63 inches and the depth .31 inches. Both nozzles had the same free opening.


TABLE XXIII.
1.—STACK 13.78 INCHES DIAMETER, $\frac{1}{2}$ FLARE, NO WAIST.

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	
1.97	+.67	28.8	+.86	44.9	+.94	58.5	1.10	90.3	
3.94	.73	28.0	.91	40.7	.90	50.5	1.19	79.6	
7.87	.69	22.7	.87	32.3	.94	40.0	1.12	57.5	
11.81	.63	18.6	.81	26.4	.87	31.0	1.04	43.4	
15.75	.57	15.1	.75	21.6	.79	24.3	.94	33.1	
19.68	.39	9.4	.57	14.8	.59	16.2	.77	23.0	
23.62	.00	0.0	+.12	2.7	+.15	3.6	+.29	7.7	
27.56	-.55	(0 @ 24.57) -.43	(0 @ 24.73) -.39	(0 @ 25.71) -.24	

2.—STACK, 13.78 INCHES DIAMETER, $1\frac{1}{4}$ FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, in.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	
1.97	.45	12.7	+.69	22.8	+.94	36.6	1.09	56.7	
3.94	.39	10.1	.60	17.5	.85	28.6	1.05	46.1	
7.87	.29	6.9	.52	13.8	.75	22.0	.98	35.5	
11.81	.24	5.2	.41	10.1	.63	16.9	.88	27.8	
15.75	.18	4.1	.33	7.6	.50	12.3	.75	21.0	
19.68	+.63	.0	.10	2.1	.17	3.8	.38	9.5	
	(0@20)		(0@20.79)		(0@21.26)		(0@22.64)		
23.62	-.31	.....	-.29	.....	-.28	.....	-.12	.....
27.56	-.71	.....	-.75	.....	-.75	.....	-.61	.....

3.—STACK 15.75 INCHES DIAMETER, $\frac{1}{2}$ FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.87 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	
1.97	.52	17.7	.80	33.2	1.00	53.1	1.11	88.2	
3.94	.48	15.5	.75	28.8	.98	46.7	1.10	72.7	
7.87	.42	12.8	.65	22.3	.89	36.0	1.06	55.1	
11.81	.36	10.2	.56	17.8	.78	28.2	.98	43.1	
15.75	.29	7.8	.47	13.8	.66	21.4	.92	34.7	
19.68	.24	6	.37	10.2	.54	16.2	.79	26.1	
23.62	.08		.19	4.6	.31	8.6	.51	15.3	
27.56	(6 @ 25.2) .15		(0 @ 26.77) .06		(0 @ 26.19) .05		(0 @ 29.93) .20	5.4	

4.—STACK 15.75 INCHES DIAMETER, $\frac{1}{2}$ FLARE (WITH WAIST).

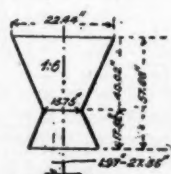
Distance of nozzle from bottom of stack, inches.	Length of stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.8 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water Column, inches.	Per cent.	Water Column, inches.	Per cent.	
1.97	.86	29.4	1.19	58.7	1.30	84.6	
3.94	.86	27.5	.....	.....	1.18	52.6	1.27	71.6
7.87	.76	21.6	.....	.....	1.06	39.4	1.18	52.6
11.81	.53	13.8	.....	.....	.85	28.1	1.04	39.0
15.75	.26	6.2	.....	.....	.60	17.3	.79	25.6
19.68	.0	.....	.....	.....	.28	7.6	.43	13.0
23.62	-.24	.....	.....	.....	(0@24.25) + .04	.....	(0@25.67) + .14	3.7
27.56	-.44	.....	.....	.....	-.16	.....	-.09	.....

TABLE XXIV.

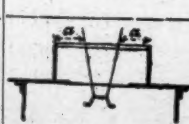
Distance of the meas'd section from the nozzle.	Amount of the distance α with a nozzle diameter of—					Remarks.
	3.94 inches.	4.33 inches.	4.72 inches.	5.12 inches.	5.51 inches.	
	Inches.	Inches.	Inches.	Inches.	Inches.	
5.51	6.10 to 6.30 (6.14)	6.02 (5.95)	5.71 (5.75)	5.51 (5.55)	5.32 to 5.57 (5.35)	 The bracketted figures form the basis of Table XXV. The other are working dimensions.
10.16	5.12 to 5.32 (5.15)	4.94 (4.98)	4.61 to 4.74 (4.78)	4.53 (4.57)	4.33 (4.37)	
14.16	4.33 to 4.55 (4.33)	4.13 to 4.33 (4.13)	3.74 to 3.94 (3.94)	3.54 to 3.74 (3.74)	3.62 (3.54)	
18.03	3.54 to 3.74 (3.62)	3.35 to 3.54 (3.43)	3.15 to 3.35 (3.23)	3.15 to 3.27 (3.03)	2.76 (2.83)	
25.75	2.17 to 2.36 (2.05)	1.77 (1.85)	1.57 (1.65)	1.38 to 1.57 (1.46)	1.18 to 1.38 (1.26)	

TABLE XXV.

Distance of the measured section from the nozzle.	Diameter of the steam jet with a nozzle diameter of					Flare of the steam jet.
	3.94 in.	4.33 in.	4.72 in.	5.12 in.	5.51 in.	
Inches.	Inches	Inches	Inches	Inches	Inches	
5.51	6.41	6.81	7.21	7.60	7.99	1 in. @2.22
10.15	8.39	8.78	9.17	9.57	9.96	1 " @2.25
14.17	10.04	10.43	10.83	11.18	11.61	1 " @2.32
18.03	11.46	11.80	12.24	12.64	13.03	1 " @2.39
25.78	14.61	15.00	15.39	15.79	16.18	1 " @2.41
Total increase in diameter.	10.67	10.67	10.67	10.67	10.67	

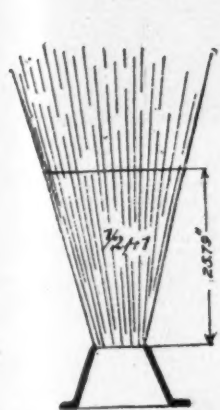


Fig. 64.

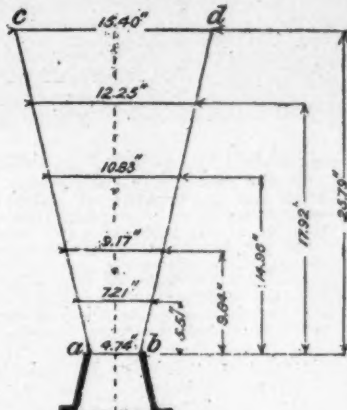


Fig. 65.

practice on modern standard gage locomotives, it is scarcely possible to put the nozzle at a shorter distance than 15.75 inches, we may consider that, for all practical purposes, the flare of the exhaust is 1 in 2.4.

This is then readily applicable to all nozzle distances up to 25.78 inches.

Beyond this latter dimension the calculation would no longer be quite as accurate, because the current of steam has its outer surface very much broken up and so fills up a somewhat greater sectional area.

This knowledge of the shape of the jet renders it possible to determine the efficiency of any chosen nozzle distance from the smallest section of the stack, as we have already shown in what precedes. If we base our calculations upon a flare of 1 in 2.4, the corresponding distance at which the smallest cross-section of the stack is just filled by a continuous jet of steam is shown in the following table for the several nozzle diameters:

Smallest diameter of stack.	Nozzle diameter.	Distance from nozzle at which the stack is filled.
11.81 inches.	3.94 inches.	1 foot 6.90 inches.
12.80 "	4.33 "	1 " 8.32 "
13.78 "	4.72 "	1 " 10.21 "
14.76 "	5.12 "	1 " 11.63 "
15.75 "	5.51 "	2 " 1.51 "

If we also make a comparison of this with the lines of the diagram of Plate I. we will see that the abscissas given in the last column are approximately the same for the given nozzle diameters and turn slightly to the horizontal, while for the shorter abscissas they are almost straight. Had the experiments been made with waist-shaped stacks with nozzle distances of 18.9 inches and a diameter of 3.94 inches it would doubtless have shown that the lines would have been very similar in their lower portions to those of the funnel-shaped stacks, which means that they would have been approximately straight. This explains the reason why there is a sharp curvature of the lines of the diagrams and their final dropping down toward the axis of the abscissas at the greater nozzle distances.

IX.—INFLUENCE OF THE BRIDGE ON THE FORM OF THE STEAM JET.

In the same manner as we described in VIII. the different sections of a stream of steam issuing from a nozzle with a bridge were measured. The nozzle had a diameter of 5.12 inches, the bridge was .63 wide and .31 inches deep. We found, in the first place, that the

circular cross-section of the jet had been changed into an ellipse by the bridge, into which the longer axis lay at right angles to the bridge.

Fig. 66 shows such a section of the jet by the cross-hatched lines for a height of 18.07 inches. The outer circle shows the ring used for the measuring; the dimensions given are those from which the axis of the ellipse were located.

It is thus seen how the wedge-shaped surface of the bridge causes the steam to make a sharp deflection at right angles to its length, while in the direction of its axis there is a smaller variation from the circular section that is quite noticeable, as is shown in Table XXVI.

TABLE XXVI.

Distance of the measured section from the nozzle opening.	Major Axis.			Minor Axis.		
	Distance a.	Diameter of steam jet.	Flare of the side of the cone.	Distance a.	Diameter of steam jet.	Flare of the side of the cone.
Inches.	Inches.	Inches.		Inches.	Inches.	
0	0	5.12		0	5.12	
10.16	2.76 to 2.95 = (2.85)	12.80	1 in 1.3	4.53 to 4.72 = (4.65)	9.25	1 in 2.36
18.03	.39 = (39)	17.92	1 " 1.4	2.95 to 3.15 = (3.03)	12.64	1 " 2.4
25.79	-.79 to .98 = -.59	20.67	1 " 1.65	1.57 to 1.77 = (1.65)	15.32	1 " 2.5

With this form of bridge we may consider that the average flare of the current of steam in the direction of the longer axis is from 1 in 1.5 to 1 in 1.6 and that in the direction of the shorter it ranges at about 1 in 2.45 as shown by Fig. 67.

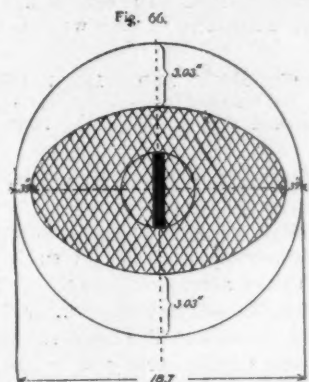


Fig. 66.

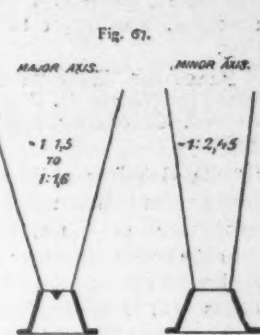


Fig. 67.



Fig. 68.

In consequence of this elliptical section the external surface of such a jet of steam has a greater area and fills the section of the stack much earlier, that is to say at a lesser distance from the nozzle opening, than would be the case with a steam jet of the same size but of circular section. Hence by an application of the bridge to a nozzle having the same free opening we have:

1. A better indraft of air or products of combustion on account of the greater surface area of the jet.
2. And also a more effective height of stack, because of the fact that the section is filled earlier on account of the elliptical form of the jet.

It may also be mentioned that with a nozzle distance of 25.79 inches the jet of steam struck against the upper edge of the ring on a line with the major axis, so that the measurement *a* became negative and should be reckoned at from .79 to .98.

Another result of the earlier filling of the section of the stack is shown in the fact that the apparatus began to throw water earlier; and that upon the locomotive spark-throwing also appeared earlier.

This shows us that the bridge is not applicable to great nozzle distance, and in general with stacks like those used on the experimental apparatus there is a throwing of water as indicated in table XXI.

(To be continued.)

New Publications.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES. 1896. H. V. & H. W. Poor, 44 Broad street, New York. 1,669 pages, 6 inches by 9 inches. Price, \$7.50.

The publishers of this well known manual in 1896 consolidated with it "Poor's Handbook of Investment Securities." As a result the volume before us includes state and municipal investments, industrial securities, etc. It has 258 more pages than the 1895 edition, and contains statements of 2,040 steam railroad companies, 1,208 street railroads, 143 industrial corporations, and 1,008 state, county, city, town, etc., debts—in all 4,399 corporations, aggregating \$16,475,000,000. The labor and expense of such a work can in a measure be appreciated from these figures. Notwithstanding the wider scope of this accurate work its price remains as heretofore.

REPORT OF THE PROCEEDINGS OF THE THIRTEENTH ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION, 1896. Pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago Ill.)

This volume needs no extensive notice by us. It appears in its usual form, is well bound, and is much larger than any previous report of the association. It contains much valuable information, as is always the case with the proceedings of this society.

BAKER'S RAILWAY MAGAZINE. Monthly. Published by Geo. H. Baker, Metropolitan Building, New York. \$3.00 per year.

The first number of this new magazine appeared last month and a copy is before us. It contains a number of interesting articles by men well known in railroad circles, and is good reading. If future issues can be maintained on the same plane as this first one the publication ought to, and, we hope, will succeed. As an inducement to prospective subscribers an art supplement (reproduced on a small scale in the first number) is for the present given with each subscription. The central figure is a woman, who ought to improve her form or else wear more clothes.

THE PRACTICAL ENGINEERS' POCKET BOOK AND DIARY, 1896. Edited by William H. Fowler. Technical Publishing Company, Limited, Manchester, England. 404 pages. 3½ by 5½ inches. 1s. 6d.

A "Pocket Book" or a dictionary always fill a reviewer's mind with despair as it is almost impossible to give an idea of their characteristics in a notice as brief as a review must necessarily be. In the present instance a nice enumeration of the subjects treated would occupy more room than can be given to the book. It begins with 19 pages of mensuration and tables, etc., which are common to all publications of this class. The next 42 pages are devoted to steam boilers in which a great variety of information is given relating to their construction and operation. This and the succeeding 79 pages devoted to the steam engine are the strong features of the book. After these chapters there are articles on the indicator, transmission of power, gas and oil engines, hydraulic and lifting machinery, friction, cutting tools, gearing, notes on heat, nickel steel, aluminum pipes, bolts and nuts, strength and weight of various materials. A feature in the latter part of the book which indicates the advance which has been made in certain directions is notes on electrical engines by S. T. Harrison, which occupies 50 pages. Notes on patents and patent law and a blank diary complete the book.

REPORT OF THE PROCEEDINGS OF THE TWENTY-NINTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, 1896. 365 pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago, Ill.)

The contents of this volume are already familiar to our readers through the report of the proceedings given in our July issue. The members will be gratified at the improvement in the binding of this volume as compared with preceding ones. It is in cloth instead of paper covers and is exceedingly neat in appearance. The plain black, relieved only by the title in gilt on the binding, is a relief from the gaily-colored designs with which each volume has been decorated in recent years, and is more in keeping with the dignity of the association.

THE UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1896. Compiled from official sources. By S. R. Blundstone, Editor of the Railway Engineer. Price, 10 shillings. The Directory Publishing Company, Ltd., 8 Catherine St., Strand, W. C., London. 374 pages, 5½ inches by 3½ inches.

This book, less than one inch thick, contains information which cannot be obtained from any other single volume published and is what its name indicates—a universal directory. Of course it does not list the very small roads in this or other countries, but

its selection of roads for publication has apparently been carefully made, and few persons would have occasion to write to officials outside of their own countries whose address cannot be found in this work. A few omissions might be noted, one being that not an operating, purchasing or mechanical official of the Southern Railway is listed, but on the whole it is an excellent compilation.

Books Received.

BULLETIN OF THE DEPARTMENT OF LABOR, No. 5. July, 1896. Edited by Carroll D. Wright, Commissioner. Washington; Government Printing Office. 1896. 122 pages.

IRON MAKING IN ALABAMA. By William Battle Phillips, Ph. D., Consulting Chemist Tennessee Coal, Iron & Railroad Company, Birmingham, Ala. Issued by the Alabama Geological Survey, Eugene Allen Smith, Ph. D., Director. 1896.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE "B." Rue Manufacturing Company, 116 North Ninth Street, Philadelphia, Pa., U. S. A. Injectors, 1896. 12 pages, 3 inches by 9 inches. (Standard size.)

This company manufactures the well-known "little giant," "fixed nozzle" and "unique" injectors, Rue's patent boiler-washing and testing apparatus, ejectors, and other jet apparatus, steam valves and boiler checks, and this catalogue is descriptive of these devices. These are illustrated and described, directions given for their application and use, and tables of size, capacity and price afford the information the purchaser desires. Catalogue "B" is a railway edition, and those desiring information about stationary injectors should write for catalogue "A."

ELECTRIC LOCOMOTIVES—Baldwin Locomotive Works, Burnham Williams & Co., Philadelphia, and the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. By David Leonard Barnes, Consulting Engineer. 123 pages, 6 inches by 9 inches. (Standard size.)

While largely descriptive of the electric locomotives that these companies have built jointly or are prepared to build, the book also contains much valuable information on electrical apparatus, presented in a way that makes it easily understood by practical mechanically trained men who have but little knowledge of electricity. Electric locomotives for passenger, freight, switching, elevated and suburban and mine traffic are illustrated, as are also the trucks, motors and controllers for them. Diagrams of horsepower, torque, speed and efficiency of motors are given, a form of specification, an outline of data required for a preliminary estimate of the cost of electrical equipment, a glossary of electrical terms and a chapter explaining "why an electric motor revolves" complete the work. In another part of this issue will be found a part of the last named chapter. The engravings and press work are of the best.

RECENT ENGINEERING WORK. Ford & Bacon, Engineers. 28 pages. 9½ by 13½ inches.

This is a handsome publication containing illustrations and descriptions of engineering work recently completed by this firm of engineers. Included in it are articles on the system of the Orleans Railroad, of New Orleans, La., the Bergen County Traction Company, in Bergen County, N. J., and an instructive article on steam piping for electric railway power plants. The illustrations show up many valuable details. This firm takes entire charge of all engineering details of construction of electric railways, including all civil, mechanical and electrical engineering connected with the work, preliminary surveys and estimates, etc. They have offices in the Mail and Express Building, New York; Philadelphia Bank Building, Philadelphia, and the Morris Building, New Orleans.

IMPERIAL GERMAN DRAWING INSTRUMENTS. Thos. Attender & Sons, Philadelphia. 16 pages. 3½ by 6 inches.

This is a current little pocket catalogue describes German drawing instruments which this firm has for sale. The engravings are good and the printing excellent.



Fig. 1.—Lidgerwood Cableway at Hilo, Hawaii.

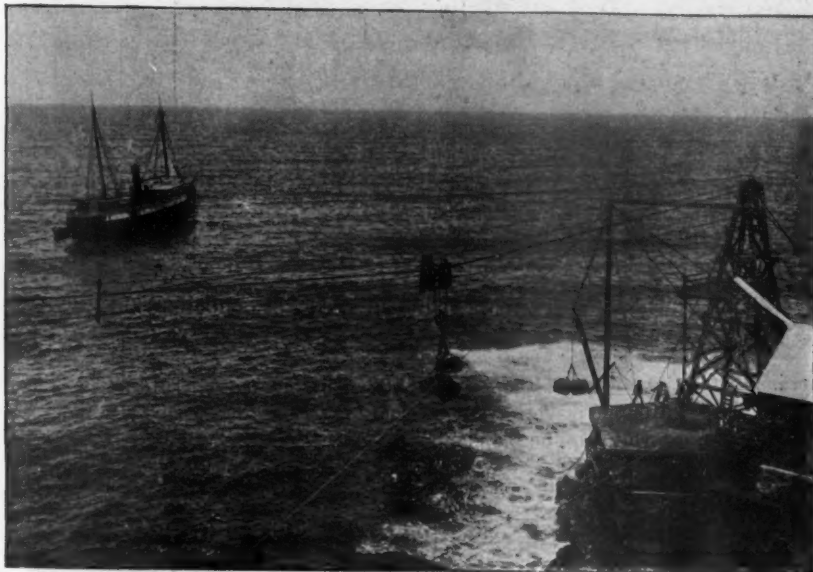


Fig. 2.—Landing Freight from Steamer, Hilo, Hawaii.



Fig. 3.—Lidgerwood Cableway, Hilo, Hawaii—Tail Tower, Warehouse Wharf and Derricks.

A Lidgerwood Cableway at Hilo, Hawaiian Islands.

We show in the three engravings printed here with an interesting and somewhat unusual installation of the Lidgerwood cableway at Hilo, Hawaiian Islands, where it is used by the Onomea Sugar Company for transporting sugar, lumber and general freights.

The coast at this point is a rough one, and it is a matter of much difficulty to convey material to and from vessels and the wharf, this being done by using small boats, as shown. The sugar or other freight is hoisted from the small boats by a number of derricks placed upon the wharf and afterward carried by the cableway up the hill to a point at the head tower. Or, if it is to be shipped, the cableway takes the material down to the landing, and from there it is transported to the vessel ready to receive it by the small boats. The cableway is of the latest improved Lidgerwood pattern with main cable two inches in diameter. The head tower is 60 feet high; tail tower 50 feet.

The average load handled is two tons. In Fig. 3 the cableway is seen transporting a load of 4,500 pounds of barley.

This cableway was furnished the Onomea Sugar Company through the Pacific Coast agents of the Lidgerwood Manufacturing Company, Messrs. Parke & Lacey Company, of San Francisco, Cal. It was set up by the native workmen at Hilo, without other help from the builders than general instructions.

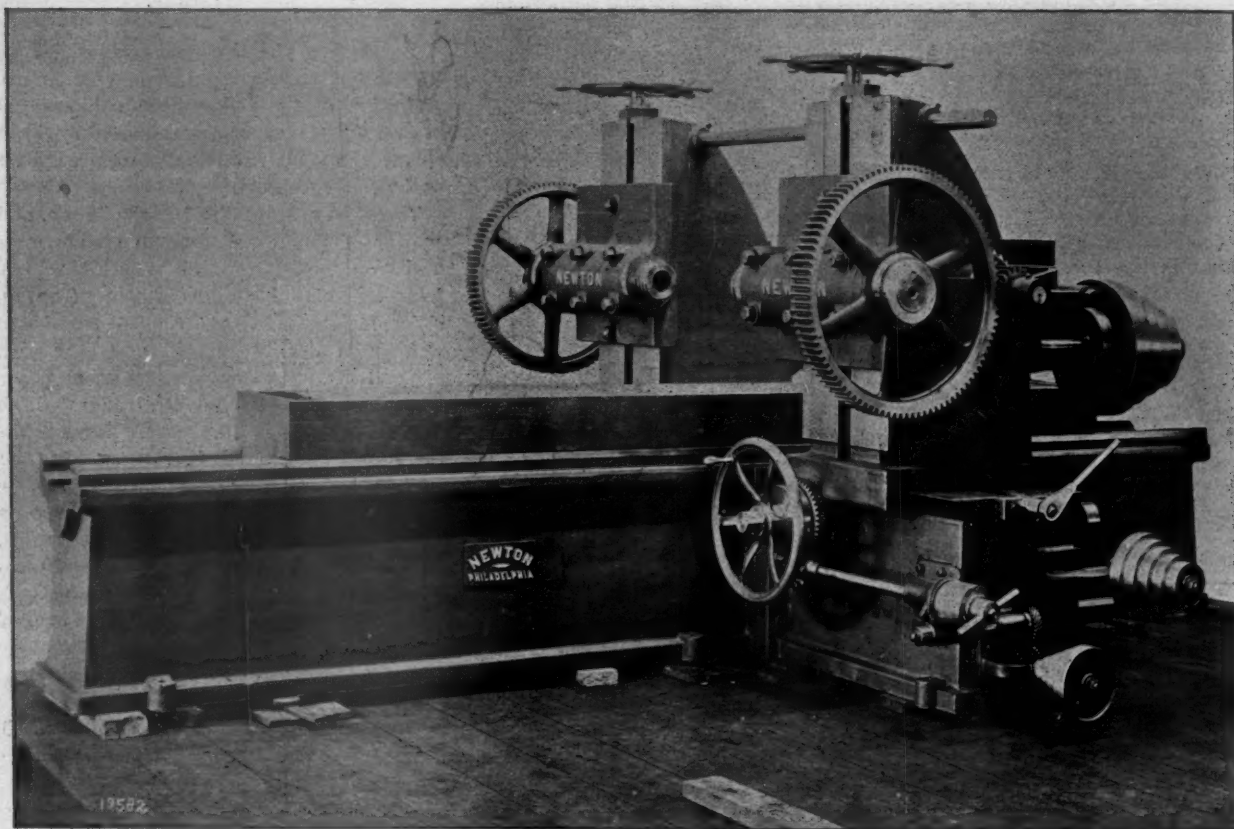
Of its working the Onomea Company say, in a recent letter to the Lidgerwood Manufacturing Company: "You will be glad to hear that the cableway is working perfectly in every way." Where convenience, dispatch and economy in operation are considered, one of the best devices for hoisting and conveying material of all sorts is the Lidgerwood cableway.

Relative Cost of Iron and Copper as Conductors.

The accompanying table, given by Mr. J. R. Allen in *The Technic*, shows the relative cost of copper in cents per pound as compared with wrought iron, Bessemer steel and cast iron in dollars per ton. The comparison is made for conductors having equivalent carrying capacity. In using Bessemer steel rails for conductors it is possible to use those that are winding and imperfect. Such rails may be purchased at a greatly reduced price.

Cost of copper, in cents per pound.	Cost of equivalent wrought iron conductor, in dollars per ton.	Cost of equivalent Bessemer steel conductor, in dollars per ton.	Cost of equivalent cast iron conductor, in dollars per ton.
7.	19.25	18.10	14.50
7.5	20.75	19.50	15.50
8.	21.50	20.30	16.75
8.5	23.75	22.25	17.75
9.	25.00	23.50	19.00
9.5	26.50	25.00	20.00
10.	28.00	26.25	21.00
10.5	29.25	27.50	22.00
11.	30.75	29.00	23.00
11.5	32.25	30.25	24.25
12.	33.50	31.75	25.25
12.5	35.00	33.00	26.25
13.	36.50	34.50	27.25
13.5	38.00	35.75	28.50

Consider the saving that can be made by the use of Bessemer rails, assuming the rails to cost \$25 per ton, as compared with copper at 11 cents per pound. Let the current to be transmitted be



A Heavy Milling Machine for Locomotive Work—Built by the Newton Machine Tool Works, Philadelphia.

1,000 amperes at 500 volts and the distance it is to be transmitted be three miles with 5 per cent. drop in voltage.

Cost of copper conductors.....	\$39,000
Cost of Bessemer steel conductors.....	23,711
Difference	\$5,289
Deducting \$400 per mile for bonding.....	1,200
Total saving.....	\$4,089
Saving per mile.....	1,363

The first use of steel rails as conductors was on the intramural road at the World's Fair. The Metropolitan and Lake street Elevated Roads, of Chicago, have adopted steel rails as conductors, as has also the New York, New Haven & Hartford Railroad, on its new extension of the electrical equipment on the Nantasket Beach line, though in the last mentioned case the rails are of special form

The Gas Exposition in New York.

During the two weeks beginning January 25, 1897, there will be held in Madison Square Garden, New York, an exposition that should attract much interest and liberal patronage. It is to be a gas exposition held under the management of the Gas Industries Company, and is the first affair of the kind attempted in this country. In a number of European countries gas exhibitions are a regular feature of each year's entertainments, and at the present Berlin exhibition the gas building is said to be one of the most pleasing and at the same time a very interesting exhibit.

The exposition in New York will be managed by a board of directors, assisted by an executive committee. It is comprised of men familiar to the commercial and financial world, whose names are a guarantee that this project will be a complete success in every particular. The executive committee will come in more direct touch with exhibitors. As appointed that body consists of the following gentlemen:

E. C. Brown, Chairman; W. H. Bradley, Chief Engineer Consolidated Gas Company of New York; Col. W. E. Barrows, President Welsbach Light Company; Walton Clark, General Superintendent United Gas Improvement Company, Philadelphia; Emerson McMillin, President The Gas Companies of St. Louis, Mil-

waukee, Columbus (O.) and Grand Rapids (Mich.). The offices for the present will be located at 280 Broadway, Rooms 237-8, where applications for exhibition spaces can be made or information of any character relating to the exposition be obtained.

The interest in the methods of gas manufacture, the qualities of gas and the appliances utilizing it for various purposes is great enough to ensure the success of the project from a mechanical standpoint, particularly under the excellent management of the present board of directors, and it should also be possible to make the exhibits equally interesting and instructive to the general public.

A Heavy Milling Machine for Locomotive Work.

The tendency toward a heavier construction of milling machines for railroad shop use is strikingly illustrated by the tool built for the new Russian-American Locomotive Works of Nijni Novgorod, Russia, by the Newton Machine Tool Works, of Philadelphia, and illustrated in the accompanying engraving. This machine is called by the builders their "No. 6 duplex milling machine," and is an advanced type of this line of tools. These duplex machines were designed in 1885, and intended principally for locomotive work. The first built were the No. 4, which weighed about 10,000 pounds. The requirements of milling machines increased and the company placed on the market a larger size, which was classed as the No. 5. When Mr. Dixon, the Chief Engineer of the Sormovo Company (of which the new locomotive works is a part) was investigating the merits of milling machines, he decided upon one of still heavier construction, namely the No. 6. This can be used for milling and completing drivingboxes, milling two sides at one time, milling out for the shoes and wedges and milling the inside to admit the cellar. These are the heaviest requirements of the machine. On rod work the machine can be used for panelling by removing the face cutters and using two ordinary panelling cutters on the end of each spindle, two rods can be panelled at one time. With flat rods, an ordinary heavy cutter can be used, one head then acting as a live head and the other as a tail support for the arbor. This machine is of an exceptionally heavy design. Its total weight, with a carriage to mill 11 feet long, is 33,000 pounds. The spindles of the machine

are 6 inches in diameter, the carriage 23 inches wide and 12 feet long to mill 11 feet in length. The spindles can be raised 26 inches from centre to carriage and will admit work 45 inches wide between the facing heads. The spindles are driven with large spur gearing; the driving pinion shaft, has a phosphor bronze triple lead worm wheel which is driven by a Harveyized steel worm, with the thrust collars of phosphor bronze and Harveyized steel. With this arrangement, an enormous power is given to the spindles and the machine is capable of handling the heaviest classes of work. The feed is suitable for the modern requirements of milling and has a range of from $\frac{1}{8}$ inch to 10 inches per minute. The carriage of the machine is fed with a rack and spiral pinion, and has a quick power movement in both directions. One valuable feature of this machine is the heavy tie rod which clamps both uprights after they are set and keeps them from springing apart on heavy cuts. Some remarkably heavy work has recently been done on one of these machines in milling large bronze driving boxes. The company has also recently patented a method for keeping cutters cool, which adds greatly to the amount of work that can be done by these machines. The spindle carrying the cutter is made hollow, and the cutter perforated with numerous small openings by which oil or water can be delivered directly on the cutting edges. The water passing through the interior of the cutter helps to keep it cool, and the quantity of it that can be delivered exactly where it will do the most good has an equally beneficial effect. On a recent test a cut $\frac{3}{4}$ inch deep was taken off a piece of forged steel 7 inches wide with a feed of 10 inches per minute, and the cutter remained cool and sharp.

Oil Tube Drills.

The accompanying cut illustrates the style of oil tube drills which are manufactured by the Cleveland Twist Drill Company, Cleveland O. In boring deep holes it is necessary that lubrication of the cutting and bearing surfaces shall be satisfactory, inasmuch as the close packing of the chips will not in such cases admit of proper lubrication by gravitation, and it is necessary to provide other means for forcing the oil down on to the cutting lips. In the drill shown this is accomplished by means of grooves cut just deep enough to admit of enclosing a small brass tube, making a smooth surface as ordinarily provided for in twist drills.

The tubes terminate at the lower ends in openings discharging



Oil Tube Drills.—Cleveland Twist Drill Co.

the oil directly at the cutting edges of the drill. The upper ends of the tubes project from the shank of the drill and through these the oil is inserted. With a high speed and heavy feed, drills heat at the points, as it is impossible to force in a lubricant, and it was to overcome this objectionable feature that these tube drills were placed on the market.

There may be several ways of conveying the oil through the tubes; the one recommended is as follows: The tubes are cut flush with the shank end, then a collet placed on the shank which fits the turret. An oil pipe is connected with the center of the turret and carried down to a chamber connecting with the butt end of the drill. The oil is forced through on to the point with considerable force, and assists in sending the chips up the flutes, and at the same time keeps the cutting lips perfectly cool. Collets are made for various-sized drills, and as the outside diameters of the collets fit the turret, a drill can be changed in a few seconds.

The company has already furnished a great many of these tools to turret lathe and bicycle manufacturers, and they are giving excellent satisfaction.

The La Villa Heaters.

The A. A. Griffing Iron Company has brought out a double line of heaters called the La Villa. We say "double line," since they make them two ways, with ornamental side-plate and base-plate and without. The capacity is the same in both, but of course the price is less for the latter. The La Villa heaters savor of stove construction. They are ornamental and portable and may even be had with removable ashpan. There are ten sizes made for steam

and a like number for water, making twenty in all. The company claims a very great amount of direct fire surface, since the entire fire pot is deeply corrugated. In the La Villa the fire has to travel three times the entire length of the heater before reaching the smoke pipe. It is very easily cleaned, for when the front and rear clean-out doors are opened every square inch of the heater is visible and accessible for a thorough cleaning. This is a very important factor in any heater. If a heater can be easily cleaned the chances are that it will be frequently cleaned, and if kept clean the economy of fuel is very marked. The best heater made if coated with the deposits of combustion, which are non-conductive in their nature, is very seriously handicapped.

The La Villa, having a rocking and dumping grate, will burn successfully soft or hard coal, coke or wood, is easily set up, comes practically in three parts, viz.:—base plate, ashpit section with grates already set in, and heater proper. It is not designed for heating large buildings, but for the thousands of small buildings such as cottages, small railway stations, etc., that are heated with steam or water every year and at a surprisingly low cost. Additional information can be obtained by writing to A. A. Griffing Iron Company, 66-68 Centre street, New York; 177-179 Fort Hill square, Boston; 702 Arch street, Philadelphia, or the works at Jersey City, N. J., mentioning this paper.

A patent was issued to the Crane Company, of Chicago, on July 28, for its Safety Valve for the Baker Heater.

The Niles Tool Works at Hamilton, O., will soon ship a large consignment of planers and boring machines to Italy and Austria.

The Vulcan Iron Works, of Chicago, has an order for new steam turning machinery, for the Grassy Point Draw of the St. Paul & Duluth Railroad, at Duluth.

The city of Chicago will receive bids until November 14 for six pumps with a capacity of 20,000,000 gallons in 24 hours. These are to be placed in a new pumping station to supply water to the north-western section of the city.

The Morgan Engineering Company of Alliance, O., shipped last month 200 tons of machinery to Russia for the new locomotive works there. There were two steam hammers, a hydraulic crane and a hydraulic flanging press.

The Edward P. Allis Company, Milwaukee, Wis., has orders for two cross compound vertical direct-acting blowing engines for export to Austria. They are said to be the largest blowing engines ever built and their weight is about 275 tons each.

The firm of Hoopes & Townsend, of Philadelphia, manufacturers of bolts, nuts, washers, rivets, etc., is particularly fortunate in having its large plant kept pretty busy during such times as these. Two of the shops are running 10 hours per day, and the others seven hours.

At a meeting of the stockholders of the Westinghouse Machine Company held last month, it was decided to increase the capital stock of the concern from \$750,000 to \$1,500,000, the new capital to be used principally in the development and manufacturing of gas engines.

The Laidlaw-Dunn-Gordon Company, Cincinnati, O., has painted on the roof of its factory, which is 665 feet long, and located close to the Cincinnati Hamilton & Dayton tracks, a sign in letters of gold, 13 feet high, the wording of which is "McKinley, Hobart and Sound Money."

The Rand Drill Company has recently received an order from the Michigan Central Railroad Company for three air compressors for its shops in Detroit and Jackson, Mich., and St. Thomas, Can.; also an order for two air compressors for the Missouri Car and Foundry Company, St. Louis.

Two rock crushers, with a daily capacity of 200 tons each, has just been shipped by the Gates Iron Works, Chicago, to the Coolgardie gold fields of West Australia. The Gates Iron Works also has an order for one of their largest crushers, capacity two tons per minute, for the Basalt Actien Gesellschaft of Kolen, Germany.

Messrs. Fitzhugh & Spencer, who have represented the Standard Steel Works and the Baldwin Locomotive Works in Chicago, have given up the agencies. The two companies have leased a suite of rooms on the twelfth floor of the Monadnock Building, Chicago, and their offices there will be in charge of Mr. Charles Riddell.

The Brightman Furnace Company, Cleveland, has sold to the Union Pacific Railway Company three of its largest stokers. Contracts now on hand include the following Cleveland firms: Jewish Orphan Asylum (fourth order), the Cleveland Steam Fitting Company, and the B. F. Goodrich Company, Akron, O., fourth order, comprising four large stokers.

The annual meeting of the stockholders of the Westinghouse Air Brake Company of Pittsburgh was held last month. The report showed that the past year had been the most prosperous in the history of the company. The gross business was \$5,947,600.57 and the profit \$2,607,936.44. The old officers and directors were unanimously re-elected. The board re-elected all of the officers.

The Wells Street bridge, Chicago, was opened to the public on the 18th, after being closed since July 3. The structure has been entirely rebuilt by the Northwestern Elevated road at an expense of \$25,000, being changed from a steam-powered highway to a double-decked bridge driven by electricity. The Shaller & Schnaigau Company, Lassig Bridge and Iron Works and Vulcan Iron Works all of Chicago, were the contractors.

The American Stoker Company has recently furnished stoker equipments to the following parties: To the Pennsylvania Railroad Company, for the shops, Columbus, O. (second order); to the Davis & Egan Machine Tool Company, Cincinnati, O.; to the Toledo Brewing & Malting Company, Toledo, O.; to the Michigan Carbon Works, Detroit, Mich. (second order); to the John C. Roth Packing Company, Cincinnati, O.; to the Cleveland City Water-Works, Cleveland, O.

The Murray Iron Works Company, of Burlington, Ia., bought up the business of the Sioux City Engine and Iron Works last spring, and proceeded to build new shops for the manufacture of Corliss engines at Burlington. These have now been completed and put in operation. As the old plant of the Murray Iron Works Company is well equipped for boiler construction and the building of slide-valve engines, the company is in a position to furnish complete power plants, either large or small.

The New York Dredging Company, World Building, New York has completed extensive terminal improvements for both the Norfolk & Carolina Railroad and the Southern Railroad, at Norfolk, Va. An extensive bulkhead has been constructed and the filling in behind it, with spoil, was done by the company's suction dredge Boston, the approaches to the wharves being deepened at the same time. The dredging plant has been towed to Atlantic City, N. J., to reclaim valuable areas of marsh land back of the city, by pumping upon them sand from an island belonging to the owners of the marsh land.

The city of Milwaukee has recently contracted for a new fire boat to be 107 feet long, 24 feet beam and 11 feet deep. The engines are to be double 18 inches by 20 inches with steel frames, and the screw 8 feet diameter. She will have two sets of pumps with a capacity of 6,000 gallons per minute, and an air pump and steam steering gear. This makes the third added to Milwaukee's fire department. The last built, the James Foley, at a trial test threw a four-inch stream of water 545 feet as measured by the city officials. The present boat is intended to be the finest in the world. The contractors for the machinery are the Chas. F. Elmes Engineering Works, of Chicago, who also built the two previously mentioned.

The Pedrick & Ayer Company, of Philadelphia, has recently received from the Safety Car Heating and Lighting Company an order for six Pintsch gas compressors to compress to 200 pounds per square inch. The company is also at work upon a pneumatic-hydraulic riveter gotten up by Messrs. Dodge and Caskey, of the Link Belt Engineering Company, and which they are preparing to manufacture and place on the market. The hydraulic riveting ram exerts a pressure of 40 tons, and this pressure is derived from compressed air at 80 pounds per square inch, operating on a piston large enough to give some thousands of pounds per square inch pressure in the hydraulic cylinder. The riveter is compact, and the first ones built have done good work.

For the purpose of extending the trade of the United States in the South American Republic of Venezuela, the National Association of Manufacturers, whose bureau of publicity is at 1751 North Fourth street, Philadelphia, proposes to open in the city of Caracas, the capital of Venezuela, a warehouse for the exhibition of American products of various kinds. A concession granted to the association by the Venezuelan government creates particularly favorable conditions for the establishment of such an enterprise,

inasmuch as goods entered for exhibit will be admitted free of duty, the customs dues to be paid only in case of actual sale. The plans for the establishment of this permanent exhibition of American goods have reached a point where applications for space can now be received, conditioned upon the allotment of a sufficient portion of the total available space to warrant the association in inaugurating the exhibition. The aim of the association is to stimulate trade between the United States and Venezuela by familiarizing the merchants of Venezuela with the American products which they can purchase to advantage. This is the objects of the proposed exhibition warehouse. Resulting orders will go through the customary channels of trade as at present. It is estimated that an entrance fee of \$100 from each exhibitor, and a charge of \$1.50 per annum per square foot of space used for exhibits will yield enough to cover, or nearly cover, the running expenses of the warehouse. The minimum charge for space has been fixed at \$25 per annum. This, with the entrance fee, would make the minimum charge for any exhibit \$125 per annum, in addition to the cost of transportation from the United States to the warehouses in Caracas. The entrance fee and the charge for space used for exhibits constitute all the charges which will be imposed upon exhibitors by the association. Parties desiring additional information should write to the Philadelphia address given above.

Our Directory

OF OFFICIAL CHANGES IN SEPTEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlantic & Pacific.—Mr. B. Burns has been appointed Chief Engineer.

Atlantic & Pacific Railroad—Western Division.—W. H. Smith, has been appointed Purchasing Agent, with headquarters at Albuquerque, N. Mex.

Baltimore & Ohio.—Mr. Wm. Sinnott is Division Master Mechanic of the second and third divisions, with headquarters at Cumberland, Md.

Central of New Jersey.—Mr. J. G. Thomas, Assistant Superintendent of Motive Power, has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Chicago & Northwestern.—Mr. W. H. Newman has resigned the position of Third Vice-President.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., vice Mr. W. E. Amann, resigned.

Great Northern.—Mr. W. W. Finley has resigned the office of Second Vice-President. He is succeeded by Mr. W. H. Newman.

Gulf, Colorado & Santa Fe.—Mr. C. W. F. Felt is Chief Engineer, with headquarters at Galveston.

Iowa Central.—Mr. Chas. W. McMeekin is Chief Engineer, with office at Marshalltown, Ia.

Kings County Elevated.—Gen. James Jourdon is Temporary Receiver.

Long Island.—Mr. W. H. Baldwin, Jr., has been elected President to succeed Mr. Austin Corbin, deceased.

Los Angeles Terminal.—Mr. William Wincup, Acting General Manager and Secretary, has resigned. Mr. S. Hynes is General Manager; Mr. F. K. Rule, Secretary, and Mr. W. J. Cox, Assistant to General Manager.

Louisville, Evansville & St. Louis.—Mr. James Gaston is appointed Master Car Builder, with headquarters at Princeton, Ind., vice Mr. W. E. Looney, resigned.

Louisville, New Albany & Chicago.—Mr. W. H. McDoel, General Manager, has been appointed Receiver.

Monterey & Mexican Gulf Railway.—E. Drageut is Superintendent of Motive Power, vice H. Nollau, previously Superintendent of Motive Power and Roadway.

New Orleans & Northwestern.—Mr. J. H. McGill has been appointed Master Mechanic in charge of locomotive machinery, water supply and car department.

New York, Philadelphia & Norfolk.—Master Mechanic C. O. Skidmore has resigned.

Norfolk & Western.—R. P. C. Sanderson, Division Superintendent of Motive Power, has resigned, and the office is abolished.

Northern Pacific.—Mr. G. W. Dickinson, General Manager of the Western lines, has resigned. Mr. W. G. Pearce, heretofore Assistant General Manager, is appointed Assistant General Superintendent, with office at Tacoma, Wash. Mr. E. H. McHenry, formerly one of the Receivers, is now Chief Engineer of the reorganized road, with office at St. Paul. Mr. W. L. Darling, formerly Chief Engineer, becomes Division Engineer, with office at St. Paul, and Mr. C. S. Bihler is Division Engineer, with office at Tacoma.

Southern.—Mr. W. W. Finley has been elected Second Vice-President, vice Mr. W. H. Baldwin, Jr., resigned. Mr. W. H. Hudson, Master Mechanic at Atlanta, has been transferred to Salisbury, N. C. Mr. W. L. Tracey is transferred from Birmingham to Atlanta, and Mr. W. A. Stone, Master Mechanic at Selma, Ala., is appointed to the position at Birmingham.

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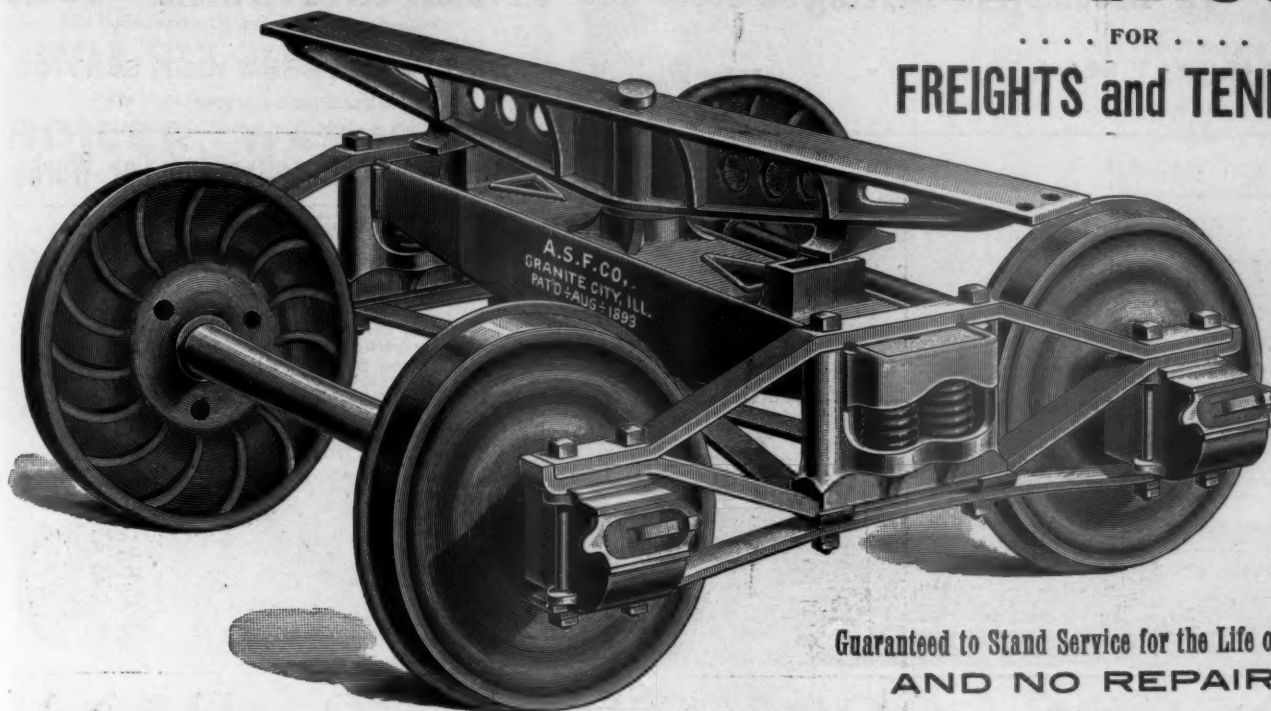
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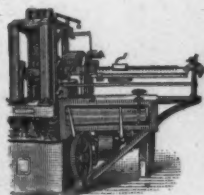
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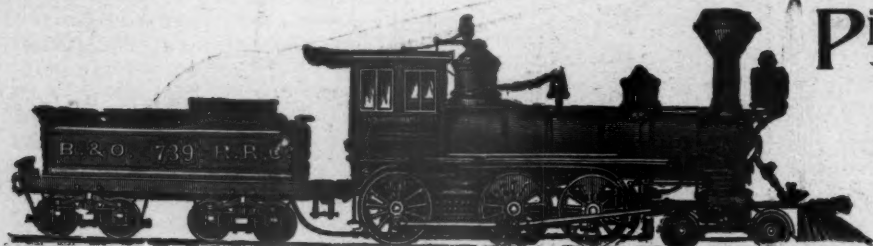


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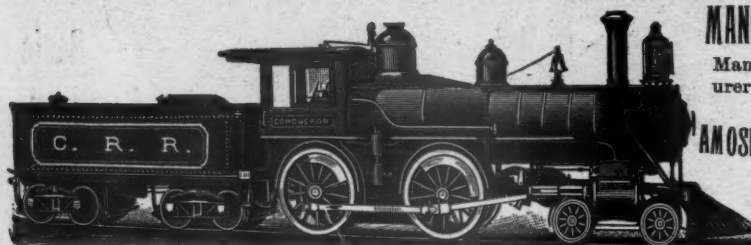
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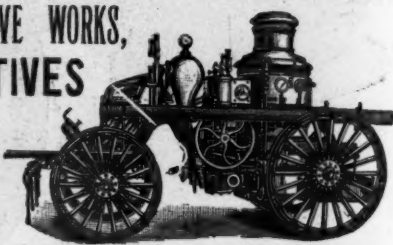
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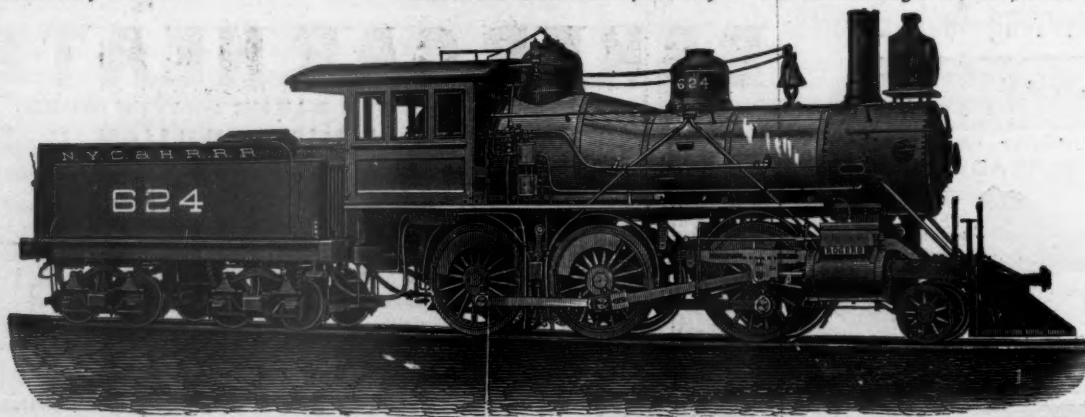
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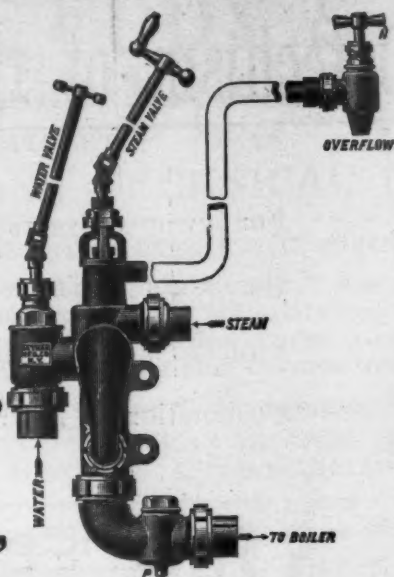
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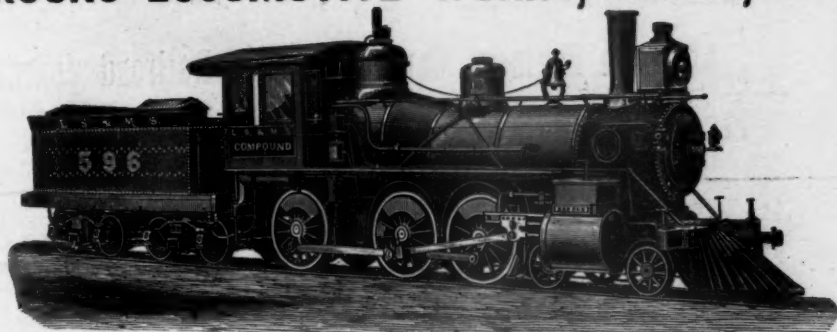
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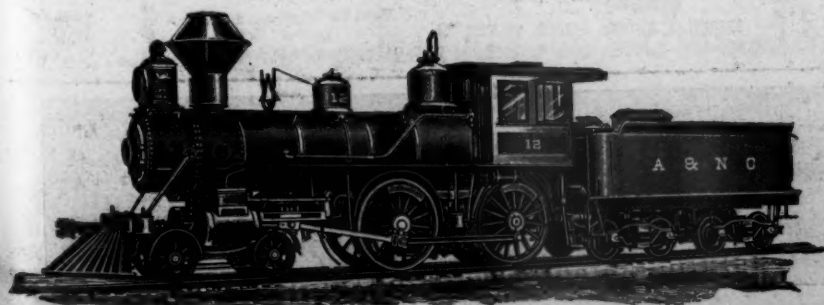
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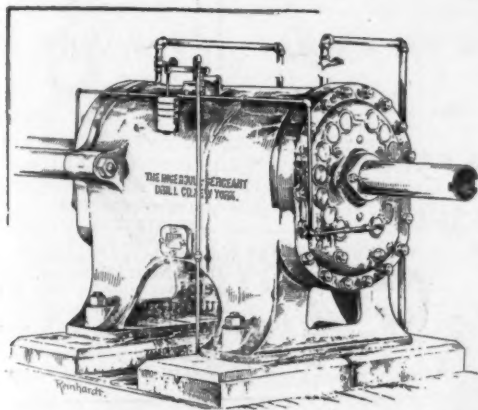
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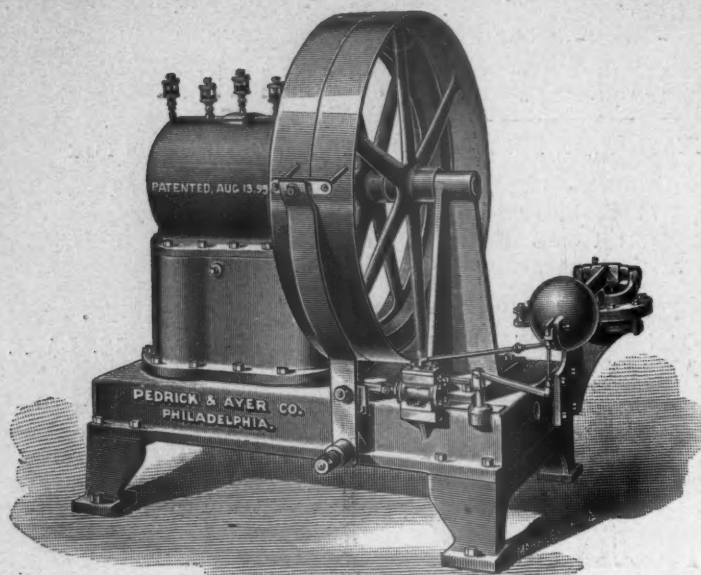
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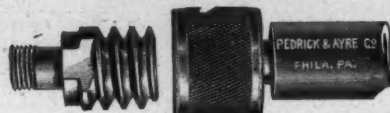


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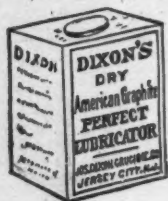
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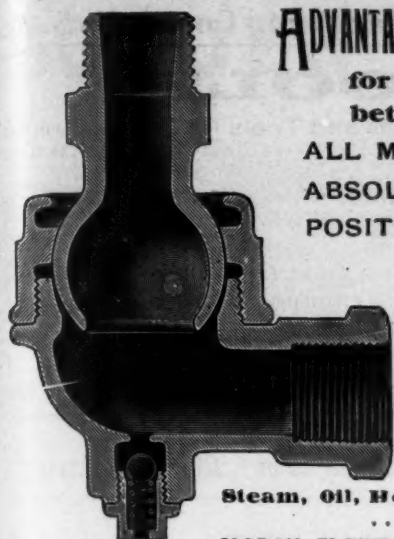
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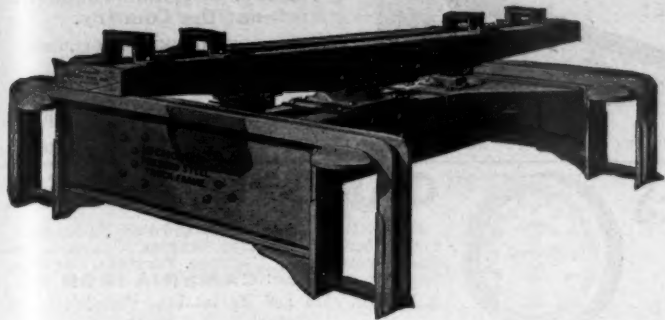
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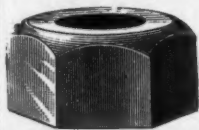
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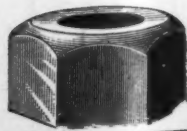
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